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Rev. 07/10/02

Remedial Action Plan
Areas 1 and 2

The Lockformer Company
711 West Ogden Avenue
Lisle, Illinois

Clayton Project No. 15-65263.04-007
July 7, 2003

Prepared for:
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1.0 INTRODUCTION

The purpose for of this Remedial Action Plan (RAP) is to identify Remedial Objectives (ROs) for soil and groundwater that were not developed as part of the Removal Action Objectives (RAOs) under United States Environmental Protection Agency (USEPA) Removal Action, present and analyze additional data collected at the site, and perform a feasibility study of appropriate groundwater remedial options for Areas 1 and 2 of The Lockformer Company (Lockformer) site. This document, in part, satisfies requirements 13 and 14 of the agreed order between the Illinois Attorney General (IAG) and Lockformer.

2.0 REMEDIATION OBJECTIVES

This RAP is not intended to be a comprehensive report of the site data. It is assumed that the reader is generally familiar with the reporting of the site data contained in the following reports and correspondence:

- Comprehensive VOC Investigation Report, May 10, 2002.
- Supplemental Comprehensive VOC Investigation Report, October 18, 2002.
- Clayton response (April 25, 2003) to the IEPA comments (received by Lockformer on February 28, 2003).
- The IEPA comment responses (May 13, 2003) to Clayton's April 25, 2003 responses.

The Area 1 and 2 soil and groundwater sampling data developed after the IEPA May 13, 2003 comment responses are presented in Section 2.1 to aid in the discussions of the ROs and the groundwater remedial action evaluations.

2.1 ADDITIONAL DATA DEVELOPMENT AND SITE ANALYSIS

2.1.1 Additional Data Development

In response to the IEPA's comments, Lockformer performed three additional soil borings north of previous soil boring CSB-1844 on the Ogden Corporate Center property to collect additional mass waste sand and gravel, lower till soil samples, and groundwater grab samples. These additional soil borings were located at 40-foot intervals north of soil boring CSB-1844 and were identified as CSB-1850, CSB-1851 and CSB-1852. The results from these additional data collection activities appear in Figures 2.1-1, 2.1-2 and 2.1-3.

Additionally, at the request of the IEPA, Lockformer investigated shallow soils in the vicinity of soil boring CSB-1809 in Area 1 to determine if a local source of contamination is present and responsible for the 17 mg/kg concentration found in the upper portion of the mass waste sand and gravel there. This work entailed advancing one boring at CSB-1809 and four borings spaced in an equidistant manner at a 30-foot radius from CSB-1809. These soil borings are identified as CSB-2221, CSB-2222, CSB-2223, CSb-2224, and CSB-2225. The results from the additional data collection activities in the vicinity of soil boring CSB-1809 appear in Figure 2.1-4.

Boring logs for soil borings CSB-1850, CSB-1851, CSB-1852, CSB-2221, CSB-2222, CSB-2223, CSB-2224, and CSB-2225 are included in Appendix A.

Figure 2.1-1 presents the results of groundwater grab samples that were acquired from the soil borings CSB-1851 and CSB-1852 for volatile organic compound (VOC) analysis on the Ogden Corporate Center property. Acquisition of a groundwater grab sample was attempted at CSB-1850 by drilling seven feet into saturated conditions in the lower silty sand lithology where groundwater was acquired in soil borings CSB-1851 and

CSB-1852. However, after waiting seven-hours, the boring would not yield a sufficient volume of water to take a sample. The two groundwater grab samples indicate no detection of any VOCs attributable to the Lockformer site. Acetone was detected in both of the groundwater grab samples and not found in the trip blank. However, acetone has been a common laboratory artifact in many groundwater samples collected at the site to date.

Figure 2.1-2 presents the results of soil sampling in the mass waste sand and gravel on the Ogden Corporate Center from the soil borings CSB-1850, CSB-1851 and CSB-1852 for VOC analysis. All three soil borings indicated non-detect concentrations for VOCs in the mass waste sand and gravel at these locations.

Figure 2.1-3 presents the results of soil sampling in the upper surface of the lower till on the Ogden Corporate Center from the soil borings CSB-1850, CSB-1851 and CSB-1852 for VOC analysis. All three soil borings indicated non-detect concentrations for VOCs in the upper surface of the lower till at these locations.

In the IEPA January 28, 2003 comments on the Lockformer Supplemental Comprehensive VOC Investigation Report, the IEPA stated "*The data suggest that TCE in groundwater is migrating off-site to the west of the Lockformer property at concentrations above 5 ppb. The width of the plume above 5 ppb at the western property boundary is more than 150 feet. Please see the comment above regarding additional delineation of groundwater contamination at the Ogden Corporate Center in addition to the recommendations listed in Section 5 of SCVOCIR. Groundwater appears to be delineated in all other directions within Areas 1 and 2.*" With regard to the additional delineation of groundwater contamination in the Recommendations in Section 5.0 of the SCVOCIR, Lockformer performed items 1 and 2 (related to the installation of MW-1122 between soil borings CSB-1840 and CSB-1002; and the five soil borings performed along the south side of the Ogden Corporate Center property CSB-1844, CSB-1845, CSB-1846, CSB-1847, and CSB-1848), and reported the results to the IEPA in the April 25, 2003 comment responses. While some detection of VOCs attributable to the Lockformer site have occurred on the Ogden Corporate Center property, no individual VOC has been found at a concentration exceeding its respective Maximum Concentration Limit (MCL) in groundwater. Item 3 from the Recommendations in Section 5.0 of the SCVOCIR related to a groundwater remedial option of pumping and containing groundwater in the vicinity of monitoring well MW-500D and soil boring CSB-1829, is addressed later in this RAP. As discussed in the July 3, 2002 meeting at Lockformer, the results of additional soil and groundwater sampling completed by Lockformer on the Ogden Corporate Center and in Area 1 around previous soil boring CSB-1809 suggest that all parties are in agreement that groundwater contamination in Areas 1 and 2 is delineated in all directions.

Figure 2.1-4 presents the results of soil sampling from five borings to a depth of 10-feet from surface grade at and around former soil boring CSB-1809 to determine if an additional source of contamination exists within this area of the site. The soil sample from each boring that exhibited the highest Photoionization Detector (PID) value was submitted for laboratory analysis of VOCs. A review of the data in Figure 2.1-4 indicates that none of the samples exceeded the Remedial Action Objectives defined in Table 3.0-1 of the Lockformer Work Plan (September 20, 2002) developed under the unilateral order on consent (106 Order) with the United States Environmental Protection Agency (USEPA). None of the soil borings encountered elevated PID or laboratory analyses in the upper soil column near surface grade suggestive of a release to the surface soils in the area.

2.1.2 Additional Data Analysis and Interpretation

To provide a better ability to visualize the occurrence of groundwater in Areas 1 and 2 at the Lockformer site, a series of east-west cross-sections across Areas 1 and 2 of the

Lockformer site and on to the Ogden Corporate Center property have been prepared. Figure 2.1-5 is a cross-section location showing the locations of cross-sections A-A', X-X', Y-Y', and Z-Z'. Figure 2.1-6 illustrates cross-section A-A', and cross-section X-X'. Figure 2.1-7 depicts cross-section Y-Y', and cross-section Z-Z'.

Cross-sections A-A', X-X', Y-Y', and Z-Z' are all generally oriented in an east-west direction, but are completed in a north-south direction with respect to one another. This allows the reviewer to gain a better 3-dimensional understanding of the subsurface across Areas 1 and 2. A review of cross-section A-A,' the northernmost of the sections, indicates that the subsurface sediments associated with the mass waste sand and gravel are unsaturated along this cross-section. This is due to an elevation rise in the surface of the lower till above the elevation at which groundwater occurs in the mass waste sediments.

A review of the next cross-section to the south, X-X', shows that the lower till surface has dipped down enough toward the south to allow the water table in the mass waste unit sediments to exhibit saturated conditions in the vicinity of soil boring CSB-1814 and monitoring well MW-522. The next cross-section to the south Y-Y', indicates the continued trend of the lower till to dip southward. Along cross-section Y-Y', local highs in the undulating lower till surface between soil boring CSB-1841 and CSB-1843, and at CSB-1812 interrupt what would appear to be a consistent water table condition in the mass waste sand and gravel sediments.

A review of cross-section Z-Z' indicates that the undulations in the lower till surface are no longer present and a consistent water table condition occurs in the mass waste sand and gravel above the lower till. This water table condition extends to the east to between soil borings CSB-1811 and CSB-1810, and is continuous to the west on to the Ogden Corporate Center property in the vicinity of monitoring wells MW-1112S and MW-1111S. South and southwest of MW-521 and soil boring CSB-521B in the vicinity of MW-1105D, the lower till rises again locally above the water table condition that exists in the mass waste sand and gravel. This data suggests that groundwater in the mass waste sand and gravel flows in a bifurcated fashion around the lower till high located in the vicinity of MW-1105D.

The visualization of the groundwater occurrence provided by the cross-sections presented in Figures 2.1-2 and 2.1-3 for the mass waste sand and gravel in Areas 1 and 2 is corroborated by both the potentiometric surface data, and the solute transport data for groundwater in Areas 1 and 2. Figure 2.1-8 is the potentiometric surface map for glacial sediments at the Lockformer site developed from static water level measurements collected on November 8, 2002. The potentiometric surface map presented in Figure 2.1-8 suggests that bifurcated flow around the lower till high in the vicinity of MW-1105D causes groundwater west of CSB-1812 (cross-section Y-Y') to flow west toward the Ogden Corporate Center property in the vicinity of groundwater monitoring wells MW-1123 and MW-1112S. Groundwater occurring in the mass waste sand and gravel on the east side of soil boring CSB-1812 generally occurs in undulations and depressions in the lower till (see cross-section C-C' in Figure 6, Supplemental Comprehensive VOC Investigation Report, October 18, 2002) until south of there in the vicinity of soil boring CSB-126B (cross-section Z-Z') and monitoring well MW-516. The Figure 2.1-8 potentiometric surface map suggests that groundwater in the mass waste sand and gravel in the vicinity of CSB-126B generally flows south/southwest toward monitoring wells MW-1102S and MW-1103S. The depression in the lower till associated with soil boring CSB-1829 appears to collect a substantial amount of groundwater runoff from its local vicinity, is likely to be hydraulically connected to the area where monitoring well MW-500D is completed (exhibiting TCE and cis-1,2-DCE concentrations of 1,870 and 3,720 ug/L, respectively), and is in close proximity to the source area in the vicinity of soil boring CSB-2017B (exhibiting a TCE soil concentration of 3,400 mg/kg). For these reasons it was recommended in the Supplemental VOC Investigation Report (October 18,

2002) that groundwater recovery efforts be initiated in this area, and why these efforts are outlined later in this RAP.

2.2 SOIL REMEDIATION OBJECTIVES

2.2.1 Upper Fill/Till Silty Clay

An evaluation has been conducted on the upper fill/till silty clay unit in Areas 1 and 2 of the Lockformer site in an effort to develop soil remediation objectives (SROs) that provide for the adequate protection of human health and the environment. The evaluation was conducted in accordance with the guidance established in Title 35 Illinois Admistrative Code, Part 742 *Tiered Approach to Corrective Action Objectives* (TACO)(35 IAC 742).

The RAOs for the site were established as part of the USEPA Removal Action Plan and are presented in Table 3.0-1 of the Lockformer Work Plan (September 20, 2002). The RAOs are based on the industrial/commercial worker SRO for the inhalation pathway contained in Appendix B, Table B of 35 IAC 742. Considering the SRO developed for the subject area cannot exceed the established RAOs, the health risk-based evaluation was focused on those exposure routes that would result in remediation objectives below the RAOs. Based on the RAO requirements, the application of an environmental land use control that restricts the property to industrial/commercial use has been assumed.

2.2.1.1 Extent of Contamination

The extent of contamination was determined by evaluating the laboratory analytical results for each of the soil samples collected in Areas 1 and 2 (Figure 2.2-1). Due to the extensive recent investigations conducted in these areas, soil samples collected by previous consultants were given little weight in the extent of contamination evaluation.

Those analyses that identified concentrations of contaminants of concern (COCs) exceeding the most conservative soil remediation objective established in 35 IAC 742 ("delineation objective", Table 2.2-1) were included in the lateral extent of the area of contamination. Additionally, for those compounds primarily identified above the delineation objectives (cis-1,2-dichloroethene, trans-1,2-dichloroethene, trichloroethene, tetrachlorethene, 1,1,1-trichloroethane, vinyl chloride, and toluene), sample analyses were also included in the lateral extent of contamination when elevated laboratory detection limits exceeded the delineation objectives.

The evaluation resulted in the development of seven individual extent of contamination configurations, one for each of the COCs (cis-1,2-dichloroethene, trans-1,2-dichloroethene, trichloroethene, tetrachlorethene, 1,1,1-trichloroethane, vinyl chloride, and toluene) that was identified above delineation objectives. The configurations are illustrated in Figures 2.2-2 through 2.2-8. A review of the figures reveals a pattern of impacts typically occurring in three individual zones; the former fill pipe area, the former vapor degreaser area, and the eastern portion of Area 2.

2.2.1.2 Tier 2 Calculation Methodology

A Tier 2 analysis has been conducted to address the "Soil Component of the Groundwater Ingestion Route" for Areas 1 and 2 of the Lockformer site. The calculation of the Tier 2 equations was performed utilizing "Taco Plus!" software as developed by ATR Associates of Arlington, Virginia. This program was developed to aid in the evaluation of soil and groundwater cleanup levels according to 35 IAC Part 742.

2.2.1.2.1 Soil Component of the Groundwater Ingestion Exposure Route

An evaluation was conducted on each of the subject COCs in a manner that would determine the concentration that could remain in the soil and still satisfy the Tier 1

Class I groundwater objective at the downgradient site limit. Additionally, an evaluation was conducted on each individual zone of impact for each COC, to provide a more realistic determination of any potential risks by incorporating site conditions specific to that area (i.e., groundwater flow direction, distance to downgradient site limit, etc.).

Each evaluation was conducted in the following manner:

1. Equation "R26" was utilized to determine the allowable GW_{source} concentration for an impacted area, given Class I groundwater objectives would be satisfied at the site limit and the distance from that point to the impacted area.

   For the R26 calculation, a site specific aquifer hydraulic conductivity value (K) of 2.43×10^{-3} cm/sec (Table 2.2-2) and an average aquifer thickness of 2 meters (~6 feet) were utilized. The TACO default value of 200 cm was utilized for the "Source Width Perpendicular to Groundwater Flow Direction in the Vertical Plane" (S_d) as per 35 IAC 742 Appendix C, Table D. To provide for the most conservative model possible, the TACO Plus! software calculated the point at which the dispersion in the z-direction was equal to the aquifer thickness. At this point no further dispersion in the z-direction was allowed. This dispersion limit provides for a more "realistic" (conservative) model, especially given the lower confining conditions of the aquifer provided by the lower till. (Figure 2.2-9).

   Equation "R26" is used to calculate the fate of a constituent in groundwater. The fate of the constituent is a function of its dispersion in the aquifer and its decay over time. The second two terms (the error function terms) in "R26" account for dispersion, while the first term (exponential term) addresses the decay of the constituent. The degree to which the constituent will decay is a function of time. The length of time for decay is the time it takes for the constituent to travel from the source area to the point of compliance. Currently, TACO implicitly assumes that the constituent travels at the same rate as the groundwater. This rate is known in TACO as the "specific discharge" (U) and is present in the denominator of the radical in the exponential term.

   TACO Plus! provides for the use of a "retardation factor" (R_f) to modify the specific discharge (U) to better represent the rate at which the contaminant moves through the saturated zone. As part of this calculation, the specific discharge (U) in equation "R26" is divided by the calculated retardation factor. The retardation factor is calculated as shown in Figure 2.2-9. Physical soil parameters required for calculation of "R26" as well as the retardation factor, were derived from both site specific values that were measured from soil samples collected within the water-bearing zone (f_{oc}), and from TACO default values (total porosity of sands/gravels)(Figure 2.2-9).

2. A combination of RCBA equation "R14" and SSL procedures was used to determine the leaching factor of a COC in an area of impact. The second term of the denominator on the right-hand-side of equation "R14" is the same as the equation "S22" for the Dilution Factor in the SSL procedure. Appendix C, Table B of TACO indicates that under the SSL procedure, either "20 or Calculated Value" can be used for the Dilution Factor in calculating remediation objectives for the protection of groundwater. The leaching factor determinations conducted during this evaluation were calculated by using the Dilution Factor of 20 in the "R14" equation.

3. Having determined the (GW_{source}) concentration and the leaching factor, equation "R12" was used to determine the RO for the Soil Component of the Groundwater Ingestion Exposure Route.

2.2.1.2.2 Cumulative Effects

The COCs were evaluated to determine if the cumulative effects of carcinogenic and noncarcinogenic compounds would require consideration. According to Appendix A, Table E of TACO, cis-1,2-dichloroethene and trans-1,2-dichloroethene have cumulative effects on the central nervous system when exposed through ingestion. Since the calculated SROs for both cis-1,2-dichloroethene and trans-1,2-dichloroethene are less that the RAOs, and will be implemented as the soil component of the GWRO, the cumulative effects of the compounds in the groundwater at the downgradient property line (point of human exposure) must be considered. Accordingly, the objectives for both cis-1,2-dichloroethene and trans-1,2-dichloroethene were reevaluated using the weighted average calculations established in 35 IAC 742.805.

According to Appendix A, Table F of TACO, trichloroethene, tetrachlorethene, and vinyl chloride have cumulative carcinogenic effects on the liver. However, since the cumulative effects of carcinogens need only be considered for groundwater in Tier 2 evaluations, and neither trichloroethene nor tetrachlorethene (using the existing RAOs as soil component of the GWRO) will coexist with each other or vinyl chloride at the downgradient property line (point of human exposure), weighted average calculations are not required.

2.2.1.3 Tier 2 Calculation Results

Table 2.2-3 presents the SROs resulting from the Tier 2 calculations and the RAOs for the subject COCs that exceeded delineation objectives.

2.2.1.4 Soil Component of the GWRO

A comparison of the Tier 2 SROs and the RAOs suggests that the most conservative of the two objectives depends on the COC and area of concern. For each of the subject COCs and each area of concern, the soil component of the GWRO will consist of the most conservative of the two objectives (Table 2.2-3).

2.2.1.5 Demonstration of Compliance with Remediation Objectives

As part of the Removal Action activities, a confirmation sampling plan was developed to demonstrate compliance with the RAOs. The sampling grids incorporated into the plan include the areas identified during the extent of contamination evaluation.

Compliance with the soil component of the GWROs will be demonstrated by averaging the results of discrete samples collected during Removal Action confirmation sampling and comparing the values to the applicable objectives. The averaging will be conducted in accordance with the methods established in 35 IAC 742.225.

2.2.2 Mass Waste Sand and Gravel

The RO for the mass waste sand and gravel in Areas 1 and 2 at the Lockformer site will be the Tiered Approach to Corrective Action Objectives (TACO) Tier I Soil Remediation Objectives for the protection of the Soil Component of the Class I Groundwater Ingestion Route established in 35 IAC 742. The ROs for the mass waste sand and gravel can be reviewed in Table 2.2-1. Lockformer installed and has begun operation of a soil vapor extraction (SVE) remediation system installed over 5.5-acres of the Lockformer site to remediate concentrations of contaminants exceeding the RO in the mass waste sand and gravel. This system began operation on June 6, 2003.

2.2.3 Upper Surface of the Lower Till

The upper surface of the lower till is not saturated over some portions of Areas 1 and 2. However, over many portions of the site the upper surface of the lower till is saturated. Generally, in areas north and east of soil boring CSB-1812 and north of cross-section X-X' in Figure 2.1-5, the upper surface of the lower till is unsaturated except in those areas where undulations or depressions in the till surface cause a localized accumulation of groundwater in the mass waste sand and gravel. The lower till hydraulically confines the lower sand and Silurian dolomite below it. Over most of Area 1 where the upper surface of the lower till is not under saturated conditions in the mass waste sand and gravel, the potentiometric head in the lower sand and Silurian dolomite rises to approximately five feet of the lower till's surface. As a result, most of the lower till unit below this upper surface is under saturated conditions due to the artesian conditions in the lower sand and Silurian dolomite, and/or exhibits saturated conditions on its surface due to saturated conditions in the mass waste sand and gravel.

The lower till has been the subject of extensive soil sampling to determine the extent of impacts to it from releases at the surface sources areas within Areas 1 and 2, as shown in

Figure 2.1-3. The vertical extent of contaminant migration through the lower till in the Area 1 source area near the former TCE fill pipe was examined through the installation of soil borings CSB-1200 through CSB-1210. Data collected from these borings is presented in cross-section view in Figures 6.1.1-7 and 6.1.1-8 from the Comprehensive VOC Investigation Report, May 10, 2002; and on cross-section B-B' in Figure 6 in the Supplemental Comprehensive VOC Investigation Report, October 18, 2002. The vertical extent of contaminant migration through the lower till in the Area 2 along the west property boundary can be observed through a review of cross-section F-F' in Figure 7 in the Supplemental Comprehensive VOC Investigation Report, October 18, 2002; and on cross-section A-A' in Figure 2.1-6 of this RAP.

A review of the data provided in the figures identified above indicates that contaminants originating from the source areas in Areas 1 and 2 have migrated down through the upper fill/till and mass waste sand and gravel to impact the lower till. In the Area 1 source area near the former TCE fill pipe, migration vertically through the lower till appears to have been inhibited by the saturated conditions in the lower till caused by its confining pressure of saturated conditions in the lower sand and Silurian dolomite. A review of the cross-sections indicates that below the static water level from MW-1108S in the former TCE fill pipe area, concentrations of TCE do not exceed 0.5 mg/kg in the lower till. Monitoring well MW-1108S was installed in the former TCE fill pipe source area to monitor the groundwater quality in the lower sand immediately below the highest concentration of contaminants in the source area soils.

Groundwater monitoring well MW-1108S has been sampled twice since its installation in May 2001, and MW-1122 has been sampled once since its installation in November 2002. Sampling from monitoring well MW-1108S indicated no detection of any VOCs in the June 2001 sampling, and a detection at or near the method detection limit of 0.55 ug/L of TCE in the August 2002 sampling event. Monitoring well MW-1122 was sampled once in January 2003 and was determined to be non-detect for all VOCs.

A review of the cross-sections for the lower till on the west side of Area 2 indicate that vertical penetration into the lower till of contaminants released from Area 2 has occurred to a greater extent than in Area 1. This vertical migration of contamination into the lower till appears to have occurred to a greater extent in the vicinity of soil boring CSB-1002 and CSB-1840. However, while water table conditions in the mass waste sand and gravel do not occur at this location, a review of the cross-sections reveals that the upper surface is approximately at the elevation of these saturated conditions, and while drilling, the soil samples obtained from the upper surface of the lower till at these locations were saturated. The vertical migration of contamination at this location appears to be associated with a local transition in the lithology of the lower till from silty clay to silty sand. For this reason, monitoring well MW-1122 was installed at this location and completed immediately below the lower till in the lower sand and weather dolomite.

The groundwater monitoring data for wells completed in the mass waste sand and gravel in Areas 1 and 2 and on the Ogden Corporate Center Property suggest that a very limited amount of contaminant migration has taken place from the source areas on site. The greatest extent of groundwater contaminant migration from the source area involving the former TCE fill pipe is likely to have occurred more specifically from the area around soil boring CSB-2017B, and appears to have primarily migrated toward monitoring well MW-1102S that has exhibited a TCE concentration ranging from 8.7 to 15.2 ug/L to date. This is a distance of approximately 310 feet. Groundwater contamination in the mass waste sand and gravel originating under the source area in Area 2 likely enters the shallow groundwater system at variable locations west of CSB-1812. The shallow groundwater contamination from Area 2 does not appear to have migrated as far west as off site monitoring well locations MW-1123 and MW-1112S. Monitoring well MW-1123 was determined to be non-detect for VOCs when sampled in January 2003. Monitoring well MW-1112S was determined to be non-detect for VOCs when sampled in both September 2001, and August 2002.

Based on these groundwater sampling results, it appears that very limited migration of site contaminants has taken place through groundwater from the source areas in Areas 1 and 2. The contaminant migration appears to have been primarily across the upper surface of the lower till to areas where groundwater saturates the mass waste sand and gravel. Migration of site contaminants vertically through the lower till to impact the lower sand and Silurian dolomite does not appear to have occurred to any appreciable extent. This observation suggests that the contaminants sorbed into the lower till interstitial matrix are not mobile to any significant degree, and as a result should not be expected to migrate to any significant degree in the future. Alternatively, SVE efforts already taking place at the site targeted at removing contaminants in the unsaturated zone in the mass waste sand and gravel will likely desorb contamination from the lower till surface through volatilization. In addition, groundwater recovery efforts (proposed in this RAP) in the saturated portion of the mass waste sand and gravel will also likely result in a contaminant mass reduction in those portions of the upper surface of the lower till where saturated conditions do not exist, and will have some control on further groundwater containment migration. Vertical migration of contaminants through the lower till can be assessed through continued groundwater monitoring in the lower sand.

As discussed, an evaluation of the data involving the upper surface of the lower till as described in the above discussion results in Lockformer proposing that a soil remediation objective is not reasonable or appropriate for the lower till. To summarize, the basis for this proposal is the following:

- Saturated conditions exist above the lower till over a large portion of Areas 1 and 2.
- In those locations where saturated conditions do not exist in the mass waste sand and gravel on the surface of the lower till, saturated conditions occur within the lower till due to it acting as a confining unit for the lower sand and Silurian dolomite.
- In those locations where saturated conditions do not exist in the mass waste sand and gravel on the surface of the lower till, saturated conditions occur variably across its surface in undulations and depressions.

- Groundwater monitoring below the lower till in the lower sand in the source areas in Areas 1 and 2 suggest that contaminant migration vertically through the lower till has not occurred to any appreciable degree.

- The SVE remedial measures taking place in the mass waste sand and gravel should reduce the mass of mobile contamination present in the lower till.

- The groundwater containment system proposed for the saturated conditions in the mass waste sand and gravel should reduce the mass of mobile contamination in the lower till, and reduce the hydraulic head that could contribute to vertical migration through the lower till.

- Contaminants sorbed into the interstitial matrix of the lower till are not expected to be mobile to any significant degree. Groundwater migration away from source areas within Areas 1 and 2 appears to be limited laterally, and not to have occurred to any significant degree vertically. After completion of contaminant mass removal through remedial activities at the site, it is anticipated that the potential impact of any residual contaminants in the lower till would be even more significantly reduced.

2.3 GROUNDWATER REMEDIAL OBJECTIVES

2.3.1 Mass Waste Sand and Gravel

The groundwater remedial objectives (GWROs) occurring within the mass waste sand and gravel on the Lockformer site in Areas 1 and 2 will be those identified in 35 IAC Section 742, Table E, for the Tier I Groundwater Remediation Objectives for the Groundwater Component of the Groundwater Ingestion Route of exposure for a Class I aquifer. Once the ROs and the RAOs for soil at the Lockformer site have been achieved, the groundwater remedy identified in Section 4 of this RAP will continue to operate until the GWROs in the mass waste sand and gravel are achieved.

2.3.2 Lower Sand and Silurian Dolomite

The GWROs occurring within the lower sand and the Silurian dolomite on the Lockformer site in Areas 1 and 2 will be those identified in 35 IAC Section 742, Table E, for the Tier I Groundwater Remediation Objectives for the Groundwater Component of the Groundwater Ingestion Route of exposure for a Class I aquifer.

To date, no verifiable detection of any VOC attributable to releases at the Lockformer site has been determined to be present within the lower sand and Silurian dolomite within Areas 1 and 2. As identified in Section 4.2 of this RAP, groundwater within this unit in Areas 1 and 2 at the Lockformer site will be subject to continued monitoring. In the event that groundwater monitoring from any individual well completed in the lower sand in Areas 1 and 2 indicates a detection of a VOC exceeding its GWRO in two consecutive groundwater sampling events, groundwater remedial measures will be undertaken in that area in the lower sand.

2.4 SURFACE WATER OBJECTIVES

Surface water bodies in the vicinity of the Lockformer site include:

- St. Joseph Creek
- West Branch of the DuPage River
- Des Plains River

St. Joseph Creek is an influent creek that typically maintains a stage level approximately 10 feet above the water table condition in the mass waste sand and gravel. Since St. Joseph Creek looses water to the glacial sediments underlying it, and is not recharged by groundwater in the vicinity of the Lockformer site, there is no need to establish surface water objectives for it.

The West Branch of the DuPage River is located approximately 4,800 feet west of the west property boundary of the Lockformer site. Groundwater at the Lockformer site does not flow toward the West Branch of the DuPage River to discharge to it, as a result, there is no need to establish surface water objectives for it.

The Des Plaines River is located approximately nine miles southeast of the Lockformer site. There is no reasonable chance of any exposure from the Lockformer site to receptors in the Des Plaines River.

3.0 GROUNDWATER FEASIBILITY STUDY

The feasibility study of various remedial options for the contaminated groundwater in the mass waste sand and gravel in Areas 1 and 2 of the Lockformer site are discussed in this section. In many respects, the nature of this feasibility analysis was shaped during discussions taking place with the IEPA, the IAG, and the USEPA in the meeting/conference call that took place on May 30, 2003. During the May 30, 2003 meeting, Lockformer presented an outline and discussion was undertaken related to the development of soil and groundwater cleanup objectives, and the general approach to addressing contaminated groundwater within Areas 1 and 2, and the performance of groundwater monitoring within Areas 1 and 2. The feasibility analysis presented here, as well as the entire approach to addressing groundwater in Areas 1 and 2 presented here, are an outcome of the May 30, 2003 discussions, and the ROs and GWROs development Section 2 of this RAP.

3.1 PERMEABLE REACTIVE BARRIER

Permeable Reactive Barrier (PRB) treatment technology for chlorinated solvent groundwater contaminant plumes underwent full-scale testing for the first time in 1992 by the University of Waterloo at the Borden Landfill in Ontario, Canada. Since then, a large number of full-scale PRBs have been installed for use in groundwater cleanups involving chlorinated solvents. The great majority of the PRBs installed to date for remediation of chlorinated solvents in groundwater have involved the use of zero valent iron as the reactive media.

The use of PRBs to treat groundwater contaminated with chlorinated solvents has generally been shown to be effective. Like any other developing technology, lessons learned over the last ten years through implementing full-scale PRB remediation has resulted in more efficient and effective installation. Some early installations were not designed and installed properly, and have lead to incomplete remediation of the solvent plumes. However, at this time, given sufficient site characterization, bench-scale and pilot-scale testing, it is reasonable to expect that a PRB can be designed and installed to effectively treat groundwater contamination at the Lockformer site. For this reason, the implementation of a PRB at the Lockformer site in Areas 1 and 2 is included in this feasibility study for evaluation.

3.1.1 Overall Protection of Human Health and the Environment

There is a high probability that given sufficient site groundwater geochemical characterization, bench-scale and pilot testing prior to implementation of a PRB remedial option that it could be effective. Successful installation of a PRB remedial measure would be effective in treating groundwater contaminants in-situ prior to crossing the Lockformer property boundary. This would have two primary benefits in terms of human health and the environment: 1) it would reduce the exposure of off site receptors, and 2) it would not result in the groundwater contaminants being brought above ground to be sorbed to other media or for discharge to the atmosphere.

If a PRB was to be chosen as the selected groundwater remedy for Areas 1 and 2 of the Lockformer site it would require a substantial amount of additional testing. This testing would likely include:

- Additional geochemical testing – This testing would be performed in order to ensure that bench-scale testing was performed under the proper conditions.
- Bench-scale testing – Bench-scale testing would be required to provide the proper design specifications of a pilot test system for evaluation prior to full scale design.

- Pilot testing – The results of the bench-scale studies would need to be pilot tested in the field at the site prior to full scale implementation of the technology in order to assess the adequacy of the initial design.

The additional testing analysis outlined above could take a year or two to carry out prior to full-scale implementation of the PRB remedial measure.

The implementation of a PRB to treat contaminated groundwater in the mass waste sand and gravel in Areas 1 and 2 would utilize the natural groundwater flow through the treatment media to effectively remove contaminants from the subsurface. When compared to a groundwater containment (pump and treat) remedial option this would result in the following potentially negative impacts:

- The hydraulic head in the mass waste sand and gravel would not be reduced and could continue to provide the vertical gradient between the mass waste sand and gravel, and the lower sand/Silurian dolomite.
- Additional portions of the mass waste sand and gravel would stay saturated and not be subject to contaminant removal by the SVE system in place and operating currently.
- No additional portions of the mass waste sand and gravel would be de-watered resulting in no additional portions of the lower till surface being exposed to the beneficial effects of the SVE remediation system to remove additional contaminant mass from its surface.

In summary, while it is very likely that a PRB remediation could be implemented effectively to be protective of human health and the environment, it is likely that potential additional exposure could occur due to the time frame under which the technology would likely be employed. Additionally, the implementation of a PRB for contaminated groundwater in the mass waste sand and gravel in Areas 1 and 2 would not offer the additional beneficial effects of de-watering portions of the sand and gravel and upper till surface exposing them to contaminant mass removal by the SVE system, and would not reduce the vertical hydraulic gradient.

3.1.2 Compliance with ARARs

There are no other known state, federal, local or county regulations that are more stringent than the 35 IAC 742 groundwater standards used to develop the GWROs for Areas 1 and 2 of the Lockformer site. A successfully designed and implemented PRB groundwater remediation in the mass waste sand and gravel would meet all applicable, relevant and appropriate (ARAR) requirements if treatment achieved the GWROs outlined in Section 2.3

3.1.3 Long-Term Effectiveness

The effectiveness of PRBs can diminish through time. The surface area of the reactive media can loose it effectiveness to treat the groundwater contaminants. In addition, in groundwater that contains elevated carbonate concentrations, precipitate may build up on the reactant surface and reduce the effectiveness of the PRB. While its safe to say the long-term effectiveness of the PRBs is an issue, there is very little data available on the long-term operation of the systems currently. As a result, the long-term effectiveness is currently unknown and can only be estimated through further study of full-scale operations. It is likely that the capital costs would be very high to replace the zero valent iron reactive media in the PRB in the case that is was exhausted.

3.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

A PRB can involve a variety of reactive media. In the case of this evaluation we have only considered zero valent iron since it has the most well documented track record of use. Using zero valent iron in a PRB largely entails the use of a chemical process that is not exactly understood. Most researchers agree that the treatment largely occurs as an abiotic reduction process of the chlorinated solvents. The nature of these discussions is too detailed to present here. There are a wide variety of papers and discussions available in the peer-reviewed scientific literature on this subject.

It is reasonable that with sufficient testing and design that a zero valent iron PRB could be implemented in Areas 1 and 2 at the Lockformer site. The PRB could be expected to treat the hazardous substances completely and not generate any hazardous byproducts if designed and installed properly. This would result in the chlorinated solvent contamination in Areas 1 and 2 being rendered non-toxic in the subsurface by the reactive media in the wall. All the research on zero valent iron treatment through use in PRBs suggests that the chemical process is irreversible; however, in some instances where the technology has been deployed the treatment has been incomplete.

3.1.5 Short-Term Effectiveness

As indicated elsewhere in this evaluation, it could take a year or two to perform the necessary testing and evaluations to be ready to implement a full-scale PRB groundwater remedial installation. This may not be a substantial problem in that the releases resulting in the source areas of contamination in Areas 1 and 2 are likely to have taken place some time between 1969 and 1981, and there is no documentation of the groundwater currently migrating across the property boundary in Areas 1 and 2 above the GWROs. As a result, it would appear that short-term risks posed to the community, site workers, and other environmental concerns should be minimal during the intervening period.

3.1.6 Implementability

A review of cross-section Z-Z' in Figure 2.1-7 suggests that a PRB installation along the west side of Area 2 to treat groundwater potentially flowing on to the Ogden Corporate Center property would need to be approximately 200 feet in length. If the west side of Area 2 was terraced to provide for the installation, the depth of installation of the PRB there would be approximately 37 to 46 feet in depth. Likewise, if a similar installation was contemplated for the south side of Area 2 in the vicinity of the groundwater monitoring well MW-1102S, the installation would require an approximate length of 200 feet, and a depth of installation ranging from approximately 40 to 54 feet.

Installation of a PRB to the depths described above would likely require the use of a mandrel system or large diameter soil mixing auger techniques. The mandrel system utilizes specially designed pile casings fitted with a detachable shoe that allows the pile casings to be driven to the target depth at which time the shoe is driven off and the pile casings are retracted while adding the zero valent iron to the subsurface. The large diameter soil mixing auger technique utilizes caisson type augers that are equipped to add cement; typically, however, for use in PRB emplacement zero valent iron and other chemicals are added. This would result in an iron and sand and gravel mixture in the PRB.

The primary drawbacks associated with the mandrel and large diameter soil mixing auger techniques are cost and feasibility of installation. Both techniques would require significant grading at the site to facilitate the large equipment necessary for use during PRB installation. There is some question as to whether either technique could be used to penetrate the mass waste sand and gravel completely due to the boulders that are regularly encountered. Because the mandrel installation technique requires the installation of large pilings, it would likely be disruptive to the business operations on the Ogden Corporate Center and the residents on Chicago and Elm Streets. The large diameter caisson augers mix the zero valent iron with the indigenous sand and gravel. The primary drawback there is a less effective individual treatment zone and the potential necessity for additional auger installations.

3.1.7 Cost

Environmental Technologies, Inc. (ETI) own the patent rights for use of zero valent iron as a remediation technique for groundwater contaminants. ETI is available to aid in the evaluation and design of PRB systems including the performance of bench-scale studies and design of pilot tests. ETI charges a 10% fee on construction costs for use of the license when implementing a zero valent iron PRB.

The cost to implement a zero valent iron PRB in Areas 1 and 2 of the Lockformer site are difficult to determine currently due to the lack of data that would need to be in hand to develop a more definitive cost (i.e., bench-scale testing, and pilot testing). Some general costs for installing and operating zero valent iron PRBs have been developed by the Oregon Graduate Institute in conjunction with ETI and distributed on the Metals for Environmental Remediation and Learning materials. These costs are summarized in Appendix B.

While the capital cost of installation for the zero valent iron PRB is significant, the cost of annual operation and maintenance is significantly less than that of groundwater containment systems. The average annual operation and maintenance costs for a zero valent iron PRB is approximately $ 30,000. The annual cost for many groundwater containment systems can be as high as $ 300,000. From a review of these costs, it is obvious that the longer the PRB is place, the more cost effective it becomes. These costs do not consider replacement of the PRB reactive media.

The net present value of the cost for the zero valent iron PRB presented above over a 30-year period, including groundwater monitoring, is $ 3,997,771. These costs can be reviewed in Appendix B. The net present value costs are based on a 30-year period. Groundwater remediation efforts could be expected to operate for a shorter period than 30 years, due to the ongoing SVE and ERH remediation.

3.1.8 Acceptance

The installation of PRBs has become widely accepted for in-situ treatment of groundwater contaminated with chlorinated solvents. The most problematic issue with the technology to date, has been the lack of initial study and gaining the proper experience through full scale installation of the technology. More recent installations have benefited from this experience and implementation of the full-scale technology over the last ten years. This has resulted in a higher probability of success for installing a PRB at this time.

3.1.9 Community Acceptance

Apart from the installation problems identified in Section 3.1.6 related to the businesses on Ogden Corporate Center and for the residents along Chicago and Elm Streets, the community acceptance for the installation of a PRB should be good. The PRB would be below grade thereby eliminating any problems related to aesthetics, and would not transfer contaminants to other environmental media to potentially impact the local community.

3.2 BIOLOGICAL TREATMENT

In recent years, complete in-situ biological treatment of chlorinated solvents in groundwater has been successfully achieved at a number of sites across the country. The following is quoted and serves well as a general introduction and summary of the degradation mechanisms available and employed when using this technology. The text is cited verbatim from Engineered Approaches to *In Situ* Bioremediation of Chlorinated Solvents: Fundamentals and Field Application, EPA 542-R-00-008, July 2000.

"Bioremediation mechanisms carried out by bacteria that typically are used for enhanced bioremediation of chlorinated aliphatic hydrocarbons (CAHs) generally can be classified into one of two of the following mechanism categories:

- Aerobic oxidation (direct and cometabolic)
- Anaerobic reductive dechlorination (direct and cometabolic)

While aerobic oxidation and anaerobic reductive dechlorination can occur naturally under proper conditions, enhancements such as the addition of electron donors, electron acceptors, or nutrients help to provide the proper conditions for aerobic oxidation or anaerobic dechlorination to occur. In general, highly chlorinated CAHs degrade primarily through reductive reactions, while less chlorinated compounds degrade primarily through oxidation. Highly chlorinated CAHs are reduced relatively easily because their carbon atoms are highly oxidized. During direct reactions, the microorganisms causing the reaction gains energy or grows as the CAH is degraded or oxidized. During cometabolic reactions, the CAH degradation or oxidation is caused by an enzyme or cofactor produced during microbial metabolism of another compound. CAH degradation or oxidation does not yield any energy or growth benefit for the microorganism mediating the cometabolic reaction." As a result, the cometabolic degradation mechanism is non-self sustaining.

To simplify the engineered biological processes for degradation of chlorinated solvents in groundwater, its reasonable to say that most peer-reviewed literature on the subject suggests that the two most successful engineered processes for degradation include:

- Complete degradation anaerobically via reductive dechlorination. That is, in the case of alkenes PCE → TCE → cis-1,2-DCE → VC → ethane.

- Partial degradation anaerobically via reductive dechlorination (i.e., PCE → TCE → cis-1,2-DCE), and the use of oxidation processes to complete the degradation cycle from cis-1,2-DCE → VC → ethane.

It should be intuitive that the microbiological processes described above work best if facilitated naturally. In recent years, the documentation of many sites where these processes are in place and occurring naturally is the basis for many non-active remediations via natural attenuation mechanisms. However, data suggests that at a large proportion of sites where the alkene chlorinated solvent contamination of groundwater occurs, the degradation of the solvent series proceeds from PCE to TCE and to cis-1,2-DCE where it stalls. A recent study (Hendrickson et. al., February 2002, Applied and Environmental Microbiology, p.485-495) of chloroethene sites in North America and Europe suggests that complete reductive dechlorination processes only occurred at sites where the microorganism group *Dehalococcoides* was detected.

At the sites where microbiological degradation stalls, the remainder of the degradation pathway remains uncompleted unless provided additional help via an engineered solution. The engineering solution is typically brought about in one of three different ways. These include:

- In situations where the system is stalled due to a lack of electron donors to continue the reductive chlorination process, carbon source addition is utilized to provide a nutrient source for further microorganism utilization.
- In situations where the system is stalled due to a lack of the presence of the *Dehalococcoides* group of microorganisms, the aquifer system is "seeded" with these microorganisms to complete the reductive dechlorination process.
- In situations where the system is stalled, but there are favorable downgradient conditions for oxidative mineralization of the chlorinated solvents, the aquifer can be supplied with an oxygen and nutrient source to complete the remediation process.

The principles discussed above provide the basis for the evaluation of the biological treatment option for groundwater containing chlorinated solvents in Areas 1 and 2 of the Lockformer site. It should be intuitive to the reviewer that, like the PRB option, the implementation of a biological treatment option for groundwater in Areas 1 and 2 will require significant further evaluation prior full-scale deployment. This testing would entail additional groundwater geochemistry and biological analyses, bench-scale testing, and pilot testing prior to the full-scale implementation of the biological treatment system.

3.2.1 Overall Protection of Human Health and the Environment

There is a high probability that given sufficient site groundwater geochemical characterization, bench-scale and pilot testing prior to implementation of a biological treatment remedial option that it could be effective. A successful biological treatment remedial measure would be effective in treating groundwater contaminants in-situ; however, at this time, it would be presumptuous to suggest that complete treatment could be carried out prior to groundwater contaminants crossing the Lockformer property boundary. The positive benefits from in-situ treatment in terms of human health and the environment include: 1) reduction of exposure to distal off site receptors, and 2) contaminated groundwater would not be brought above ground to be sorbed to other media or for discharge to the atmosphere.

If biological treatment was to be chosen as the selected groundwater remedy for Areas 1 and 2 of the Lockformer site it would require a substantial amount of additional testing. This testing would likely include:

- Additional geochemical and biological testing of groundwater – This testing would be performed in order to ensure that bench-scale testing was performed under the proper conditions.
- Bench-scale testing – Bench-scale testing would be required to provide the proper design specifications of a pilot test system for evaluation prior to full scale design.
- Pilot testing – The results of the bench-scale studies would need to be pilot tested in the field at the site prior to full scale implementation of the technology in order to assess the adequacy of the initial design.

The additional testing analysis outlined above could take a year or two to carry out prior to full-scale implementation of a biological treatment remedial measure.

The implementation of a biological treatment option for contaminated groundwater in the mass waste sand and gravel in Areas 1 and 2 would likely include nutrient and/or microorganism addition to the natural groundwater flow to facilitate treatment. When compared to a groundwater containment (pump and treat) remedial option this would result in the following potentially negative impacts:

- The hydraulic head in the mass waste sand and gravel would not be reduced and could continue to provide the vertical gradient between the mass waste sand and gravel, and the lower sand/Silurian dolomite.
- Additional portions of the mass waste sand and gravel would stay saturated and not be subject to contaminant removal by the SVE system in place currently.
- No additional portions of the mass waste sand and gravel would be de-watered resulting in no additional portions of the lower till surface being exposed to the beneficial effects of the SVE remediation system to remove additional contaminant mass from its surface.

In summary, while it is likely that a biological treatment remedial option could be implemented effectively to be protective of human health and the environment, it is likely that potential additional exposure could occur due to the potential for contaminants migrating on to the Ogden Corporate Center site, due to the time frame under which the technology would likely be deployed. Additionally, the implementation of a biological treatment option for contaminated groundwater in the mass waste sand and gravel in Areas 1 and 2 would not offer the additional beneficial effects of de-watering portions of the sand and gravel and upper till surface exposing them to contaminant mass removal by the SVE system, and would not reduce the vertical hydraulic gradient.

3.2.2 Compliance with ARARs

There are no other known state, federal, local or county regulations that are more stringent than the 35 IAC 742 groundwater standards used to develop the GWROs for Areas 1 and 2 of the Lockformer site. A successfully designed and implemented biological treatment groundwater remediation in the mass waste sand and gravel would meet all ARARs if treatment achieved the GWROs outlined in Section 2.3

3.2.3 Long-Term Effectiveness

It is likely that any biological treatment option employed would require some further maintenance addition to facilitate efficient attenuation mechanisms. This would likely result in occasional further nutrient addition. At this time, it is difficult to predict the nature and duration of these activities; however, the level of effort and costs associated with these activities is not anticipated to be extensive.

3.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

It is reasonable that with sufficient testing and design a biological treatment remedial option could be implemented successfully in Areas 1 and 2 at the Lockformer site to reduce the volume of contamination in groundwater. A biological treatment system in groundwater is capable of fully degrading the hazardous substances and would not generate any hazardous byproducts if implemented properly. This would result in the chlorinated solvent contamination in Areas 1 and 2 being rendered non-toxic in the subsurface by the biological treatment process. There is no suggestion in the literature that the biological treatment process is irreversible; however, in some instances where the technology has been deployed the treatment has been incomplete. In these instances, there is the potential that more toxic constituents like vinyl chloride could accumulate in the aquifer.

3.2.5 Short-Term Effectiveness

As indicated elsewhere in this evaluation, it could take a year or two to perform the necessary testing and evaluations to be ready to implement a full-scale biological treatment groundwater remedial option. This may not be a substantial problem in that the releases resulting in the source areas of contamination in Areas 1 and 2 are likely to have taken place some time between 1969 and 1981, and there is no documentation of the groundwater migrating across the property boundary in Areas 1 and 2 above the GWROs currently. As a result, it would appear that short-term risks posed to the community, site workers, and other environmental concerns should be minimal during the intervening period.

3.2.6 Implementability

A large number of vendors that specialize in biologic degradation of chlorinated solvents are available for assisting in the assessment of the biological treatment option for implementation. However, it's also fair to say that the number of credible vendors that have a successful track record treating chlorinated solvents in groundwater are limited to a few. Laboratory and consulting services specializing in biological assay and analysis, bench-scale testing, pilot testing and full-scale implementation can be utilized if necessary. Several vendors posses the most recent knowledge available on full-scale projects utilizing biological treatment processes related to chlorinated solvents.

A primary concern regarding the implementability of the biological treatment option is the potential for incomplete biological treatment of the groundwater contaminants prior to transport across the property boundary. In this instance, supplemental amendments of microorganisms or nutrients might need to be introduced in downgradient wells to ensure completion of the biological treatment process. If biological treatment processes did not perform adequately in the field, a groundwater containment option could be implemented to abate further downgradient migration.

3.2.7 Cost

Data related to the cost of biological treatment of chlorinated solvents in groundwater is not readily available. The costs to implement this technology identified below is a result of experience Clayton Group Services has had at other sites and from information gathered through vendors. These costs are provided in Appendix B.

In addition to the capital costs outlined in Appendix B, yearly groundwater monitoring, and operation and maintenance of the biological treatment system need to be factored into the cost evaluation to allow a net present value calculation. These costs are also presented in Appendix B. The net present value costs are based on a 30-year period. Groundwater remediation efforts could be expected to operate for a shorter period than 30 years, due to the ongoing SVE and ERH remediation.

3.2.8 Acceptance

The use of biological treatment for chlorinated solvents in groundwater has gained general acceptance in recent years by the regulatory community due to successful, full-scale implementation. The most problematic issue with the technology, has been the lack of initial study understanding of the site, prior to full scale installation of the technology. Recent publication of full-scale installations have benefited the scientific and engineering community, and allow the experience gained through the successful implementation of the technology to be applied elsewhere.

3.2.9 Community Acceptance

The use of biological treatment as a groundwater remediation technique in Areas 1 and 2 at the Lockformer site should be generally accepted. As identified in Section 3.2.1, the only realistic potential for adverse off site impacts would appear to be present at the Ogden Corporate Center in the instance that complete degradation did not occur prior to contaminants being transported across the Area 2 property line. In that instance, a contingency would be to apply additional biologic treatment in downgradient locations or to pump and contain groundwater in those areas.

3.3 GROUNDWATER CONTAINMENT

This alternative involves the extraction of groundwater from the saturated portions of the mass waste sand and gravel downgradient of Areas 1 & 2. A series of groundwater extraction wells would be installed at the site to capture contaminated groundwater and eliminate migration offsite. Captured groundwater would be treated with air stripping and activated carbon before being discharged to the sanitary sewer.

Figure 3.3-1 illustrates the proposed locations of the five (5) groundwater recovery wells. Figures 3.3-2 and 3.3-3 are geologic cross-sections showing the location of the saturated zone within the Mass Waste Sand and Gravel and the proposed location of the groundwater recovery wells. The wells have been located within areas of the mass waste sand and gravel that have the maximum saturated thickness in Areas 1 & 2.

3.3.1 Overall Protection of Human Health and the Environment

This alternative will be protective of human health and the environment by capturing contaminated groundwater before it can migrate offsite. The captured groundwater would be treated prior to discharge to the sanitary sewer system. In addition, a groundwater pumping and containment system would have the beneficial effect of dewatering portions of the mass waste sand and gravel to provide for mass removal by the currently operating SVE system in that unit; it would expose additional surface area of the lower till to facilitate mass removal from its surface by the SVE system; and it would reduce the vertical hydraulic gradient across the lower till to the lower sand and Silurian dolomite, thereby, reducing the chance of additional contaminant migration.

3.3.2 Compliance with ARARs

Potential ARARs have been identified for the Area 1 & 2 groundwater based on the current level of knowledge about site conditions and regulatory involvement.

ARARs identified for the Area 1 & 2 groundwater, relevant to developing remedial objectives are identified in Section 2 of this RAP.

The groundwater containment alternative will comply with the above-referenced ARARs through the containment of the contaminated groundwater and elimination of groundwater with concentrations of the contaminants of concern above the Maximum Contaminant Levels (MCLs) from migrating offsite the Lockformer site.

3.3.3 Long-Term Effectiveness

Implementation of the groundwater containment alternative will provide good long-term effectiveness. The residual risk remaining throughout the implementation of this alternative will be low based on complete capture of the contaminated groundwater. The groundwater containment will provide adequate control of the groundwater migration throughout implementation. The groundwater recovery and treatment technology to be used for this alternative is very reliable and is not a new technology.

3.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The groundwater containment alternative will utilize pneumatic pumps to recovery the groundwater. Recovered groundwater will be pumped back to the Lockformer facility where it will undergo primary treatment with a diffuser/air stripper followed by secondary treatment with liquid-phase granular activated carbon before being discharged to the sanitary sewer.

A total of 5 recovery wells are proposed for this alternative to provide the required groundwater containment on the Lockformer site. Each well is expected to produce up to approximately 2.5 gallons per minute (maximum sustainable average based on hydraulic conductivity values and averaged for seasonal occurrence) for a combined flow rate of 12.5 gallons per minute.

To determine the expected groundwater influent concentration, the most recent groundwater analytical results were evaluated from the nearest monitoring well. Table 3.3-1 below summarizes this data.

Table 3.3-1
TCE Concentrations Near Proposed Recovery Wells

Recovery Well	Closest Monitoring Well	TCE Concentration in Monitoring Well
RW-1	MW-500D	1,870 ug/L
RW-2	MW-1117	41.8 ug/L
RW-3	MW-1117	41.8 ug/L
RW-4	MW-521	11 ug/L
RW-5	MW-517D	76 ug/L

The influent groundwater concentration is expected to be approximately 400 ug/L assuming that each well produces 2.5 gallons per minute. The treatment technologies included in this alternative (i.e., air stripping and carbon adsorption) are very effective for these relatively low groundwater concentrations. Effluent discharge concentrations are expected to be well below any discharge criteria and are anticipated to be at or below the laboratory detection limits for the contaminants of concern.

A total of approximately 18,000 gallons per day could be expected to be processed by the system assuming that the maximum expected flow rate is consistently met. This will equate to a total of 6.5 million gallons per year of water recovered and treated.

3.3.5 Short-Term Effectiveness

Groundwater containment will be effective almost immediately. Due to a limited saturated zone within the mass waste sand and gravel, capture and control of the groundwater should be accomplished within a couple of weeks of startup.

No short-term risk to the community during construction or during operation will be present. Construction of the groundwater containment will require drilling and trenching through some contaminated soils. Proper health & safety procedures (similar to those used extensively for the installation of the soil remediation systems and the onsite investigations) will be implemented to eliminate any impacts on the construction workers.

Since this alternative only involves the recovery and treatment of contaminated groundwater, it is anticipated that there will be no short-term environmental impacts to the site or surrounding community.

A major advantage of this alternative is the short time frame to implement this remedy. No bench-scale or pilot-scale testing will be required to design and/or implement this alternative.

3.3.6 Implementability

A primary advantage of this alternative is the ability to immediately implement the remedy. Adequate information on the location and the expected production of the groundwater recovery wells currently exists to design and install the system. Furthermore, the treatment technologies to be used are industry standards and will not require any bench or pilot testing to prove they will work.

Existing building space and other equipment (i.e., liquid-phase carbon treatment system, air compressor for pumps) will streamline the implementation of this alternative. Electrical service is available in the compressor room (room directly west of the new remediation building). Installation of the groundwater recovery wells and underground air and water piping will be relatively easy to implement. This alternative is expected to be implemented following successful completion of the Electrical Resistive Heating (ERH) remediation in Areas 1 & 2. Therefore, installation of RW-1 and the trenching through the existing plenum will not be impacted by the soil remediation activities.

3.3.7 Cost

A cost estimate for the design, construction, and operation of the groundwater containment alternative was developed. The costs of construction and operation assumed that the ERH soil remediation in Areas 1 & 2 would be complete prior to implementation. The capital cost estimate also assumed the following:

- Currently existing liquid-phase carbon treatment system will be used for treatment polishing prior to discharge;
- Existing space within the compressor room will be adequate for the installation of the additional remediation equipment;
- Electrical service is readily available within the compressor room for the treatment equipment; and

- The existing vapor-phase carbon system will be used to treat air emissions if necessary from the air stripper.

Items such as design, permitting, health & safety, construction oversight, contingencies, and closure/decommissioning were determined as a percentage of the construction total. The costs can be reviewed in Appendix B.

Annual operation and maintenance costs included groundwater monitoring/reporting, carbon replacement, sequestering agent to prevent fouling of the treatment equipment, system operation & maintenance, and period well rehabilitation and pump replacement throughout the life of the project. All of the O&M costs were converted to net present value costs over the predicted 30-year life assuming a 5% discount rate annually. The net present value costs can be reviewed in Appendix B. The net present value costs are based on a 30-year period. Groundwater remediation efforts could be expected to operate for a shorter period than 30 years, due to the ongoing SVE and ERH remediation.

In comparison to the other alternatives, the capital and incremental operating costs (i.e., above the groundwater monitoring that will be required for each alternative) are relatively low. This alternative will provide a cost effective way to implement groundwater remediation in Areas 1 & 2.

3.3.8 Acceptance

Groundwater containment will meet the requirements to eliminate migration of contaminants off of the Lockformer property. Based on the state groundwater quality requirements, the containment of contaminated groundwater on the Lockformer property will be protective of human health and the environment and therefore should be acceptable to the Illinois Environmental Protection Agency (IEPA).

3.3.9 Community Acceptance

Minimal disruption of the site and impact to the surrounding community will be realized through the implementation of this alternative. Recovered groundwater will be transported through underground pipelines and treated before discharging to the sanitary sewer. Air discharge from the air stripper will also be treated if necessary to meet state emission requirements.

It is expected that the implementation and operation of the groundwater containment system will be acceptable to the surrounding community.

3.4 NO ACTION

3.4.1 Overall Protection of Human Health and the Environment

While there is no verifiable detection of any VOCs to date in the lower sand and Silurian dolomite in Areas 1 and 2; and there has not been a determination of an exceedence of any VOC GWRO in groundwater monitoring wells in the mass waste sand and gravel that indicate migration across the Areas 1 and 2 boundary; it is likely that if no remedial action is implemented for the mass waste sand and gravel groundwater exceedences of the GWRO at the property boundary will occur. However, due to the soil remediation efforts taking place at the site, significant groundwater quality improvements in the mass waste sand and gravel will likely be observed in the near future without implementing a groundwater remedy. This suggests that while a groundwater remedy in the mass waste sand and gravel is necessary currently, the duration of the groundwater remediation efforts may not need to be lengthy.

3.4.2 Compliance with ARARs

The likelihood that groundwater contaminants would migrate across the Areas 1 and 2 property boundary above MCLs if no action were to occur suggests non-compliance with state and federal groundwater standards.

3.4.3 Long-Term Effectiveness

Since long-term effectiveness of a no action option would take into consideration the soil remediation efforts that are currently under way, and the cleanup objectives for the soil remediation have taken into consideration the soil migration to groundwater pathway, it is conceivable that the long-term effectiveness of the no action option would sufficiently address groundwater contamination at the site. Under this scenario, short-term exceedences of the MCL at the property boundary would be short lived as the source concentrations and mass additions to the mass waste sand and gravel would be reduced by the soil remediation system. Groundwater attenuation processes would likely result in the no-action option as being in compliance with the state and federal groundwater standards at the property boundary at some point in time in the near future.

3.4.4 Reduction of Toxicity, Mobility, or Volume through Treatment

A no-action option would not reduce the toxicity, mobility or volume of groundwater contamination through treatment.

3.4.5 Short-Term Effectiveness

A no-action option would likely result in exceedences of the GWRO in groundwater of the mass waste sand and gravel at the Areas 1 and 2 property boundary in the short term; thereby, rendering the option as ineffective.

3.4.6 Implementability

There would be no technical obstacles to implementing a no-action option for groundwater in Areas 1 and 2 at the Lockformer site.

3.4.7 Cost

To implement a no-action option effectively, additional monitoring wells and more regular sampling of monitoring wells would likely be required. Additional costs associated with this monitoring are presented in the no action capital cost analysis in Appendix B. Net present values for the no action option are also presented in Appendix B.

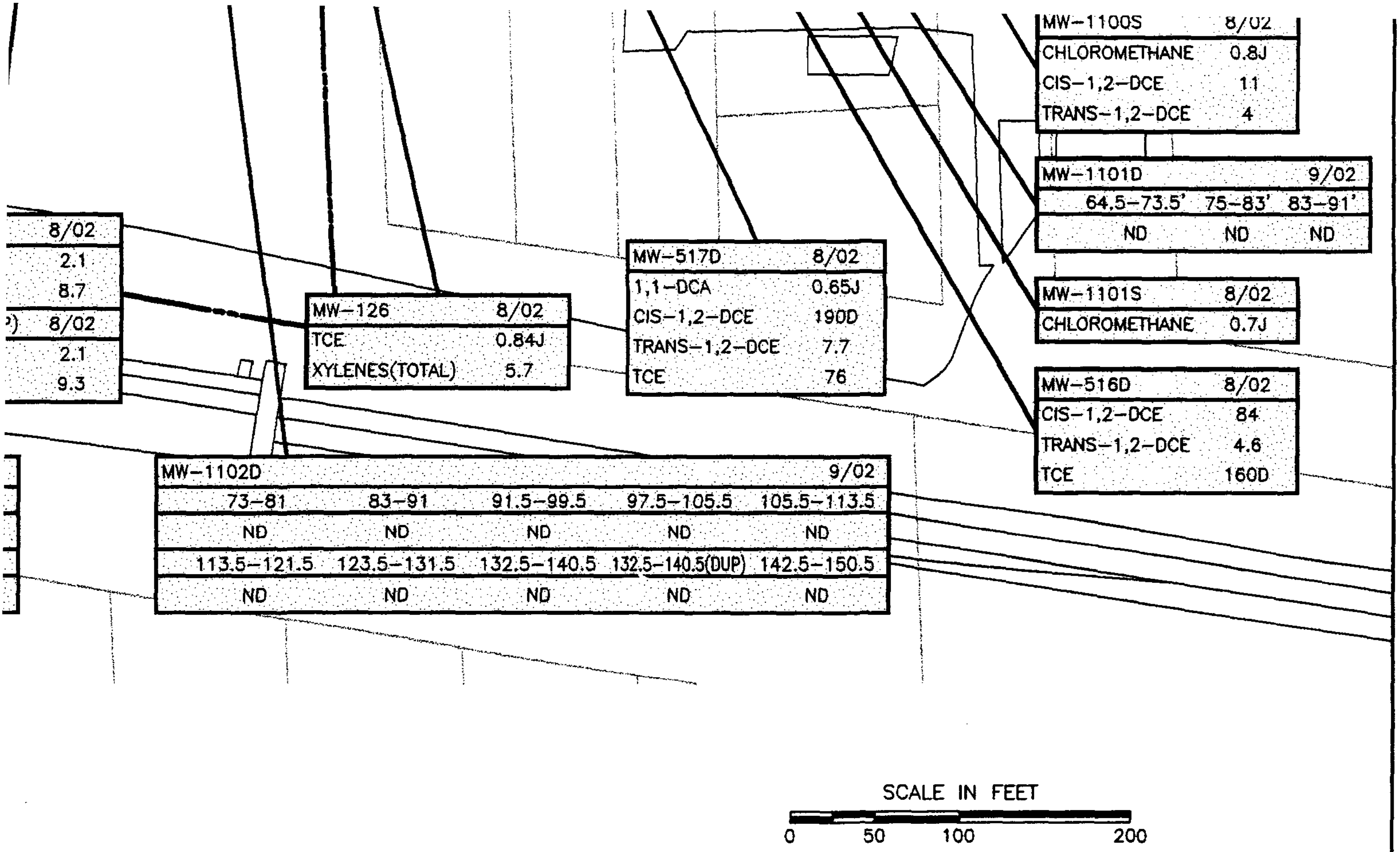
3.4.8 Acceptance

It is not likely that state and federal regulators will accept a no-action option for groundwater in Areas 1 and 2 of the Lockformer site due to the potential for groundwater standards to be exceeded at the property boundary.

3.4.9 Community Acceptance

It is not likely that adjacent property owners will accept a no-action option for groundwater at the Lockformer site due to the potential for their sites to negatively be impacted by groundwater contamination.

FIGURES

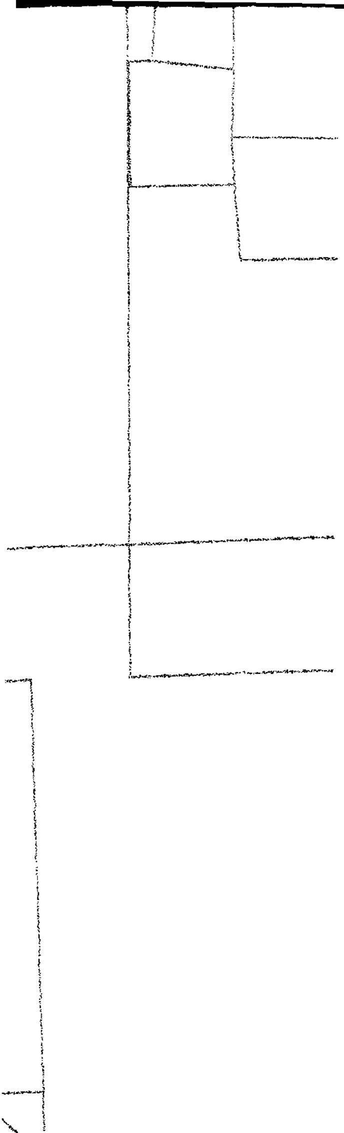


GROUNDWATER ANALYTICAL RESULTS
FOR AREAS 1 AND 2

THE LOCKFORMER COMPANY
711 W. OGDEN AVENUE
LISLE, ILLINOIS

FIGURE

2.1-1



ND NON-DETECT

NOTE:

1. RESULTS SHOWN IN ug/kg OR PARTS PER BILLION.

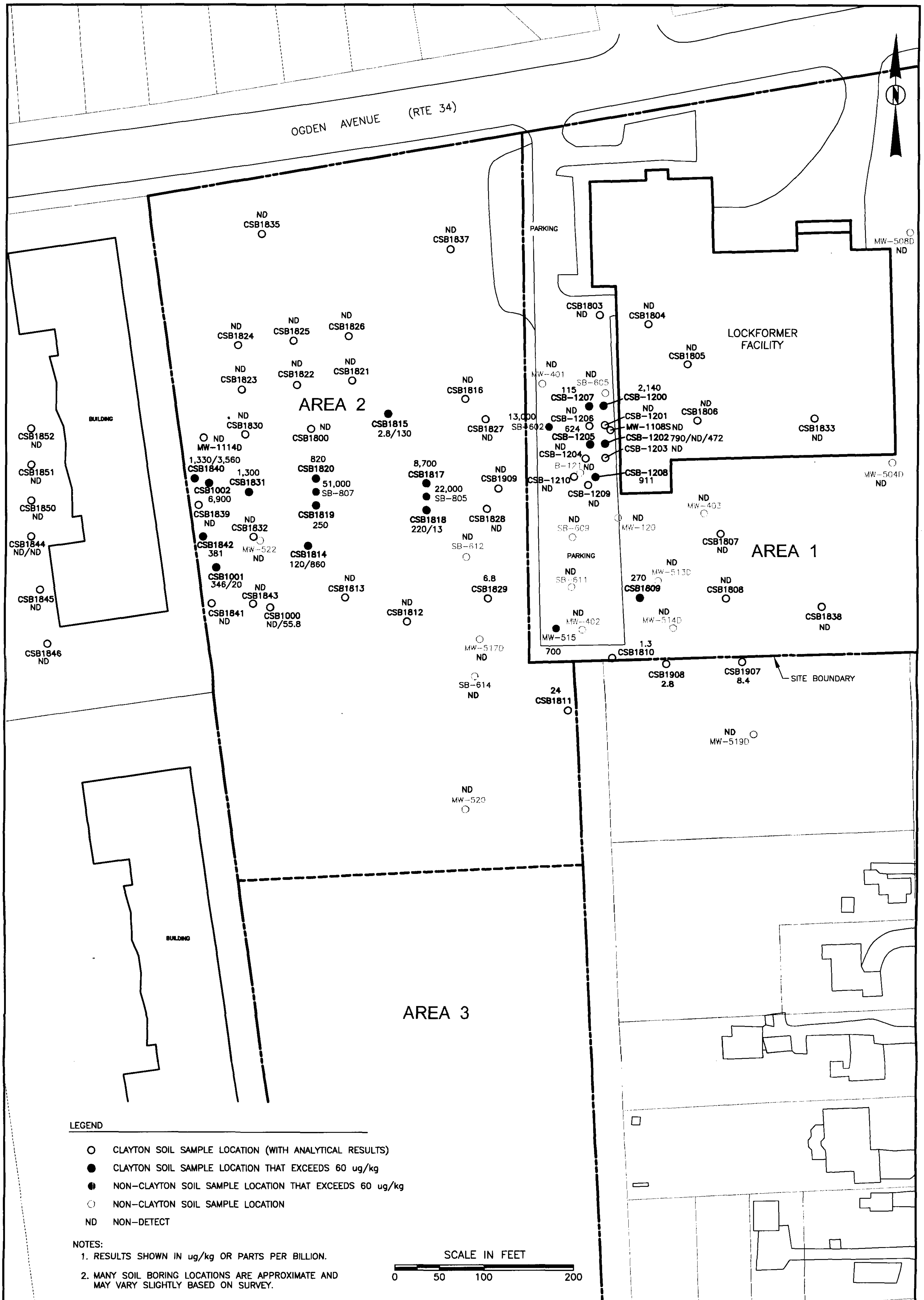
SCALE IN FEET

0 25 50 100

TCE SOIL ANALYTICAL RESULTS
FOR THE MASS WASTE IN
AREAS 1 & 2
THE LOCKFORMER COMPANY
711 W. OGDEN AVENUE
LISLE, ILLINOIS

FIGURE

2.1-2

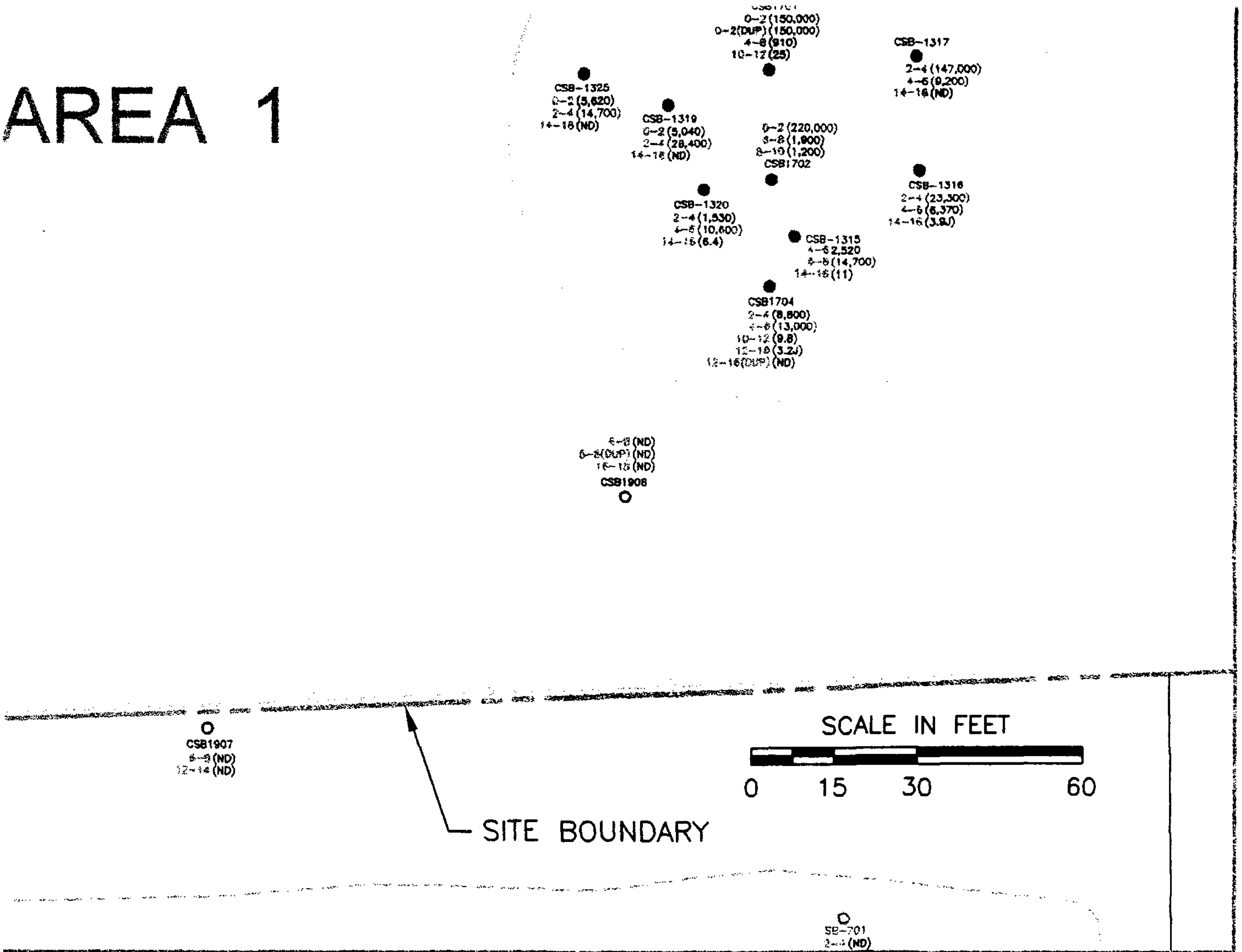


CHECK BY	
DRAWN BY	BCP
DATE	4-25-03
SCALE	AS SHOWN
CAD NO.	6526316Q
PRJ NO.	65263.01

TCE SOIL ANALYTICAL RESULTS
FOR THE LOWER TILL UNIT
IN AREAS 1 AND 2
THE LOCKFORMER COMPANY
711 W. OGDEN AVENUE
LISLE, ILLINOIS

Clayton℠ GROUP SERVICES

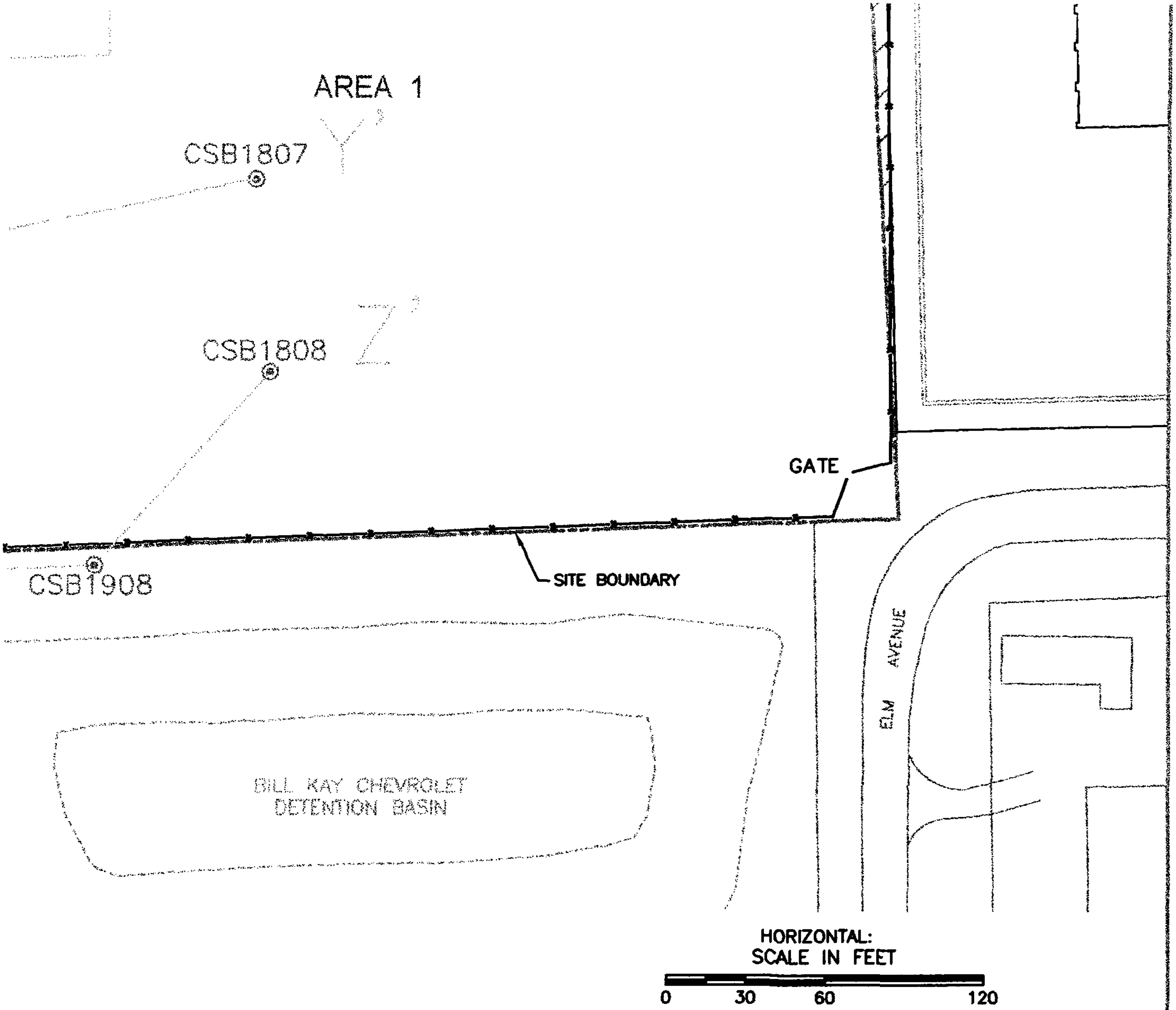
FIGURE 2.1-3



TCE SOIL ANALYTICAL RESULTS FOR THE
UPPER SILTY CLAY, TILL/FILL
IN AREAS 1 & 2
THE LOCKFORMER COMPANY
711 W. OGDEN AVENUE
LISLE, ILLINOIS

FIGURE

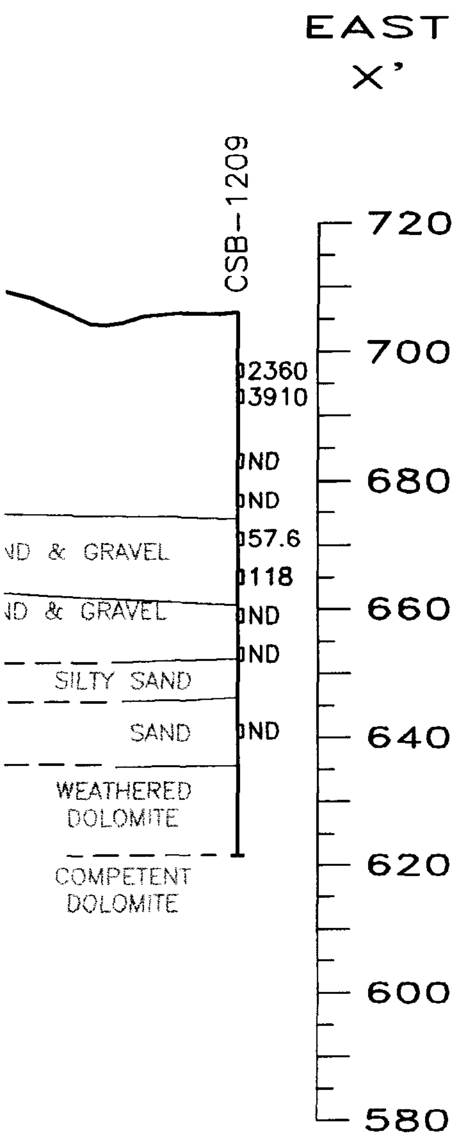
2.1-4



JB	CROSS SECTION REFERENCE PLAN
06-24-03	THE LOCKFORMER COMPANY
AS SHOWN	711 W. OGDEN AVENUE
6526316V	LISLE, ILLINOIS
65263.01	

Clayton℠ GROUP SERVICES

FIGURE 2.1-5



LEGEND

▼ APPROXIMATE POSITION OF WATER TABLE IN THE MASS WASTE UNIT SAND & GRAVEL ON NOV. 8, 2002

SCREEN INTERVAL AND TCE CONCENTRATION DETERMINED IN GROUND WATER (2003)

]118 TCE CONCENTRATION IN ug/kg

HORIZONTAL:
SCALE IN FEET

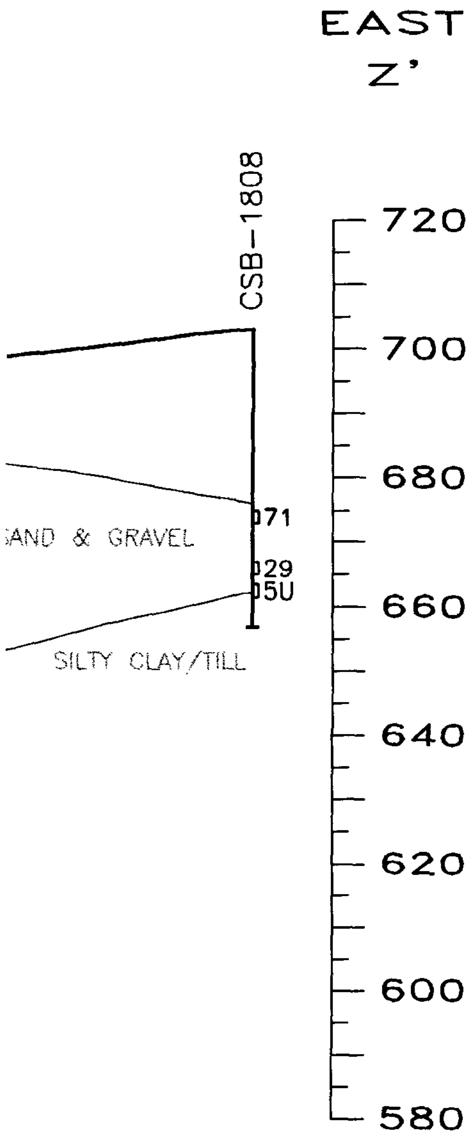
0 30 60 120

VERTICAL EXAGGERATION = 2X

3	CROSS SECTIONS A – A' & X – X'
7–01–03	
S SHOWN	THE LOCKFORMER COMPANY
526316T	711 W. OGDEN AVENUE
5263.01	LISLE, ILLINOIS

Clayton℠ GROUP SERVICES

FIGURE 2.1–6



LEGEND

APPROXIMATE POSITION OF WATER TABLE IN THE MASS WASTE UNIT SAND & GRAVEL ON NOV. 8, 2002

SCREEN INTERVAL AND TCE CONCENTRATION DETERMINED IN GROUND WATER (2003)

]118 TCE CONCENTRATION IN ug/kg

HORIZONTAL:
SCALE IN FEET

0 30 60 120

VERTICAL EXAGGERATION = 2X

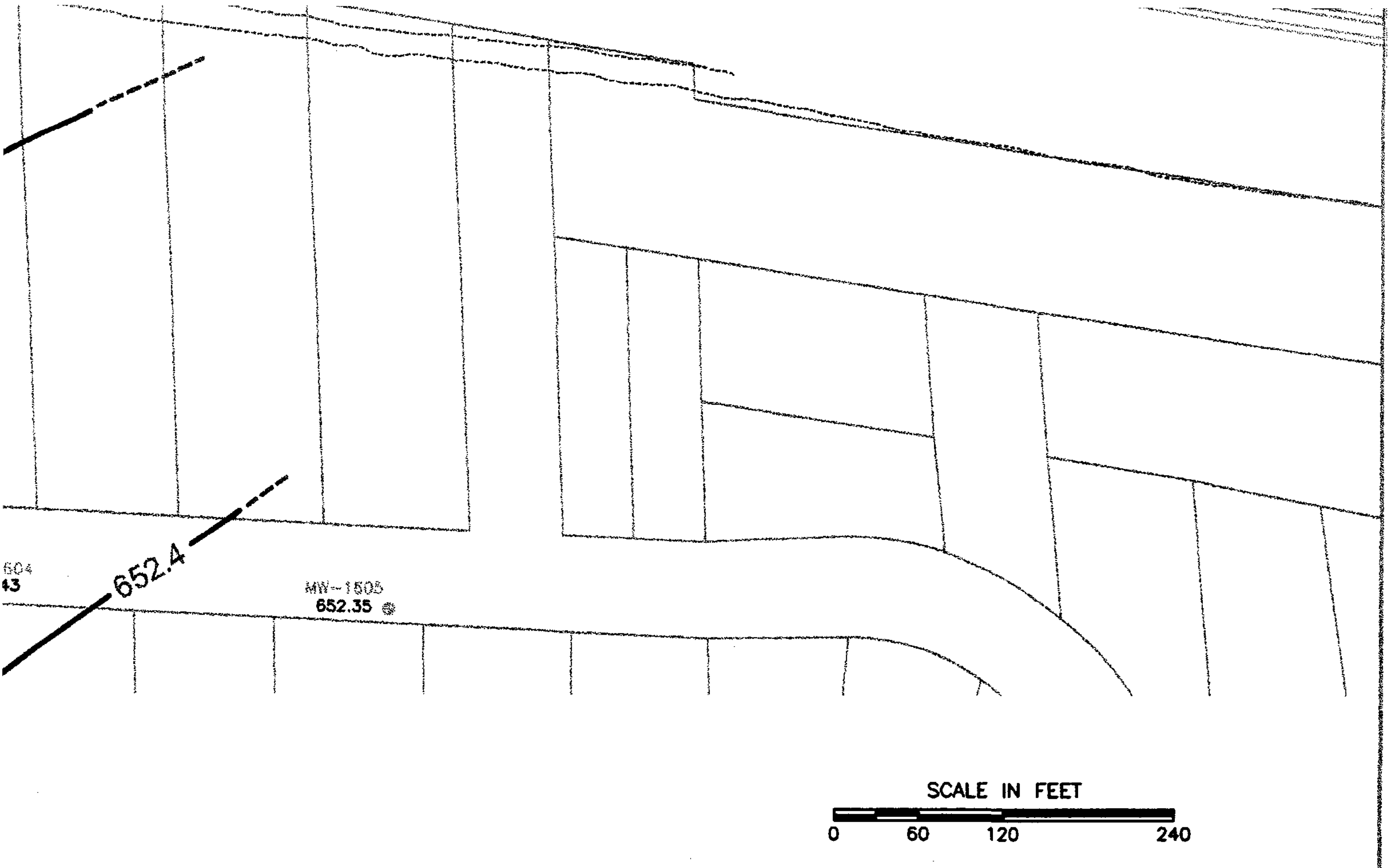
-03
WN
6T
1

CROSS SECTION Y - Y' & Z - Z'

THE LOCKFORMER COMPANY
711 W. OGDEN AVENUE
LISLE, ILLINOIS

Clayton GROUP SERVICES

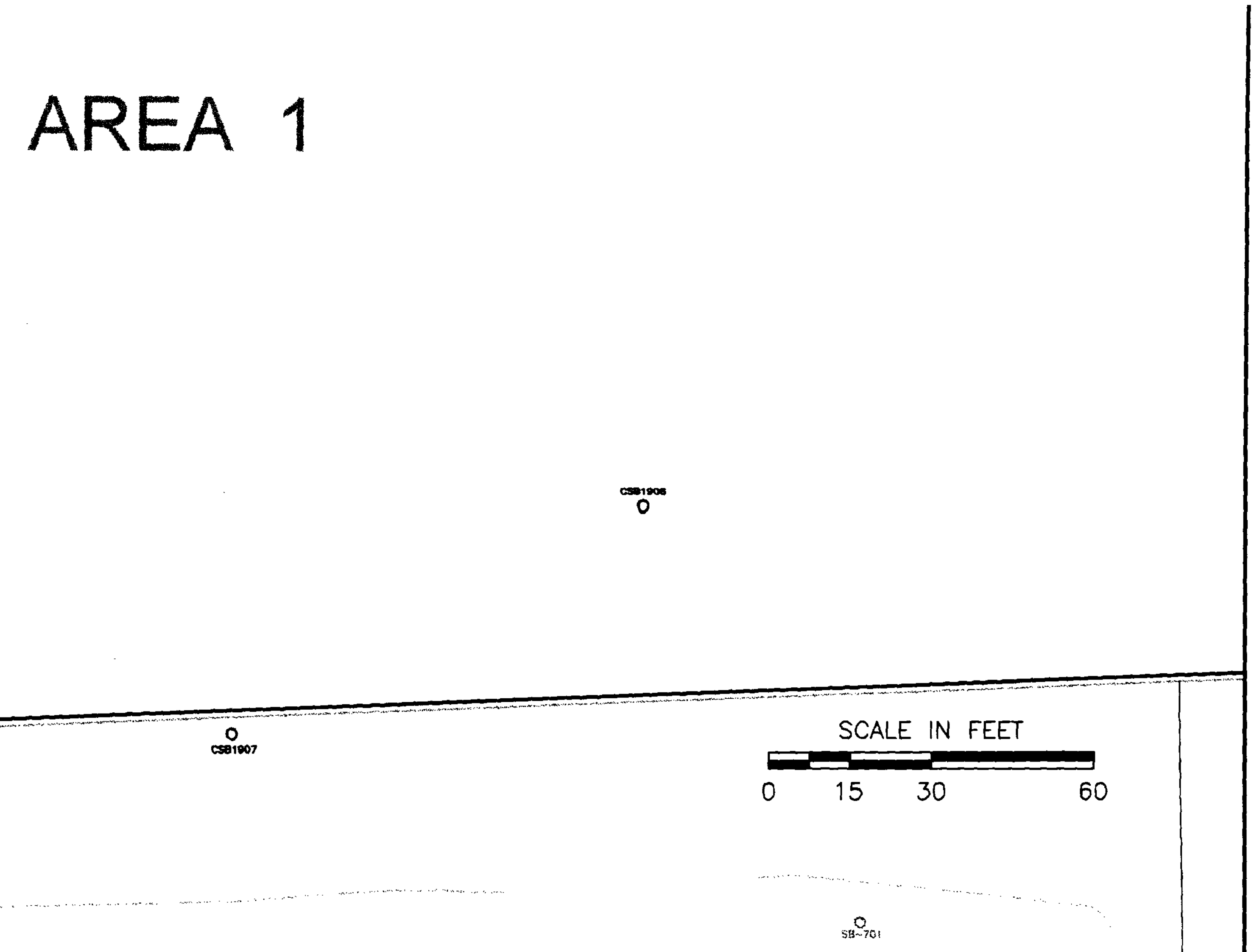
FIGURE 2.1-7



POTENTIOMETRIC SURFACE MAP OF THE
MASS WASTE UNIT GLACIAL SEDIMENTS
ON NOVEMBER 8, 2002
THE LOCKFORMER COMPANY
711 W. OGDEN AVENUE
LISLE, ILLINOIS

FIGURE

2.1-8

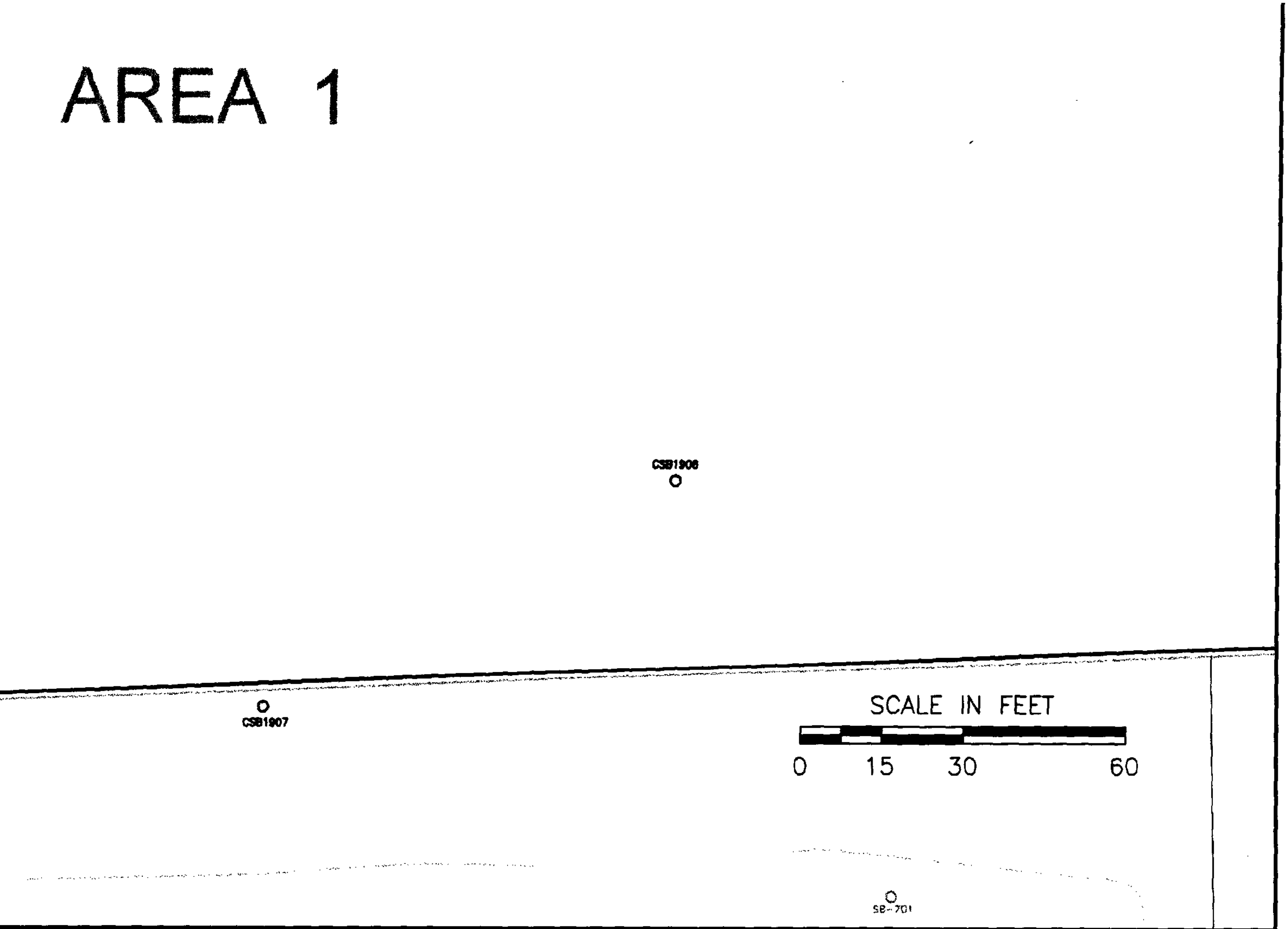


EXTENT OF CONTAMINATION SAMPLING LAYOUT MAP
UPPER TILL/FILL IN AREAS 1 & 2

THE LOCKFORMER COMPANY
711 W. OGDEN AVENUE
LISLE, ILLINOIS

FIGURE

2.2-1

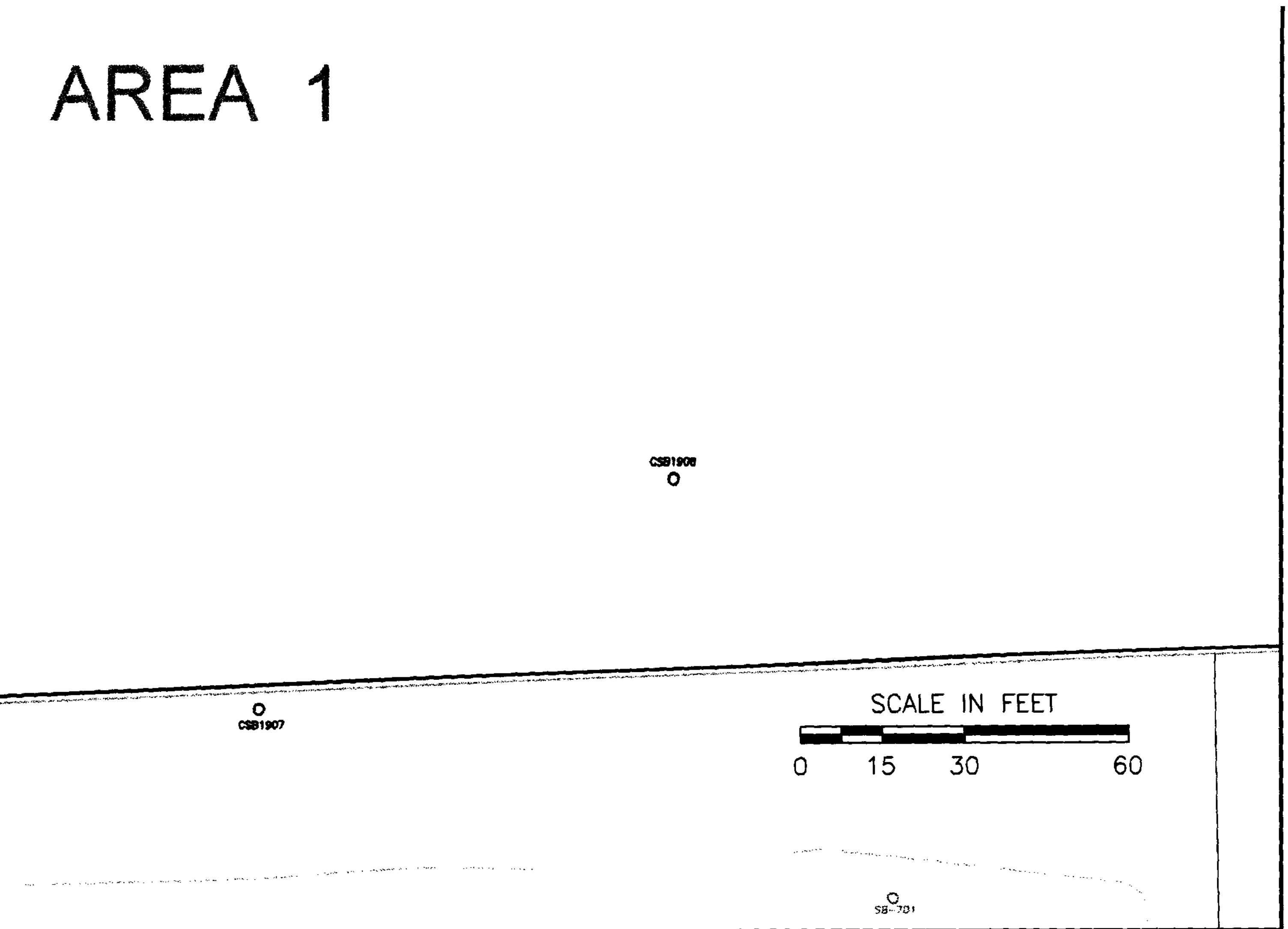


CIS-1,2-DCE DELINEATION MAP
UPPER TILL/FILL IN AREAS 1 & 2

THE LOCKFORMER COMPANY
711 W. OGDEN AVENUE
LISLE, ILLINOIS

FIGURE

2.2-2

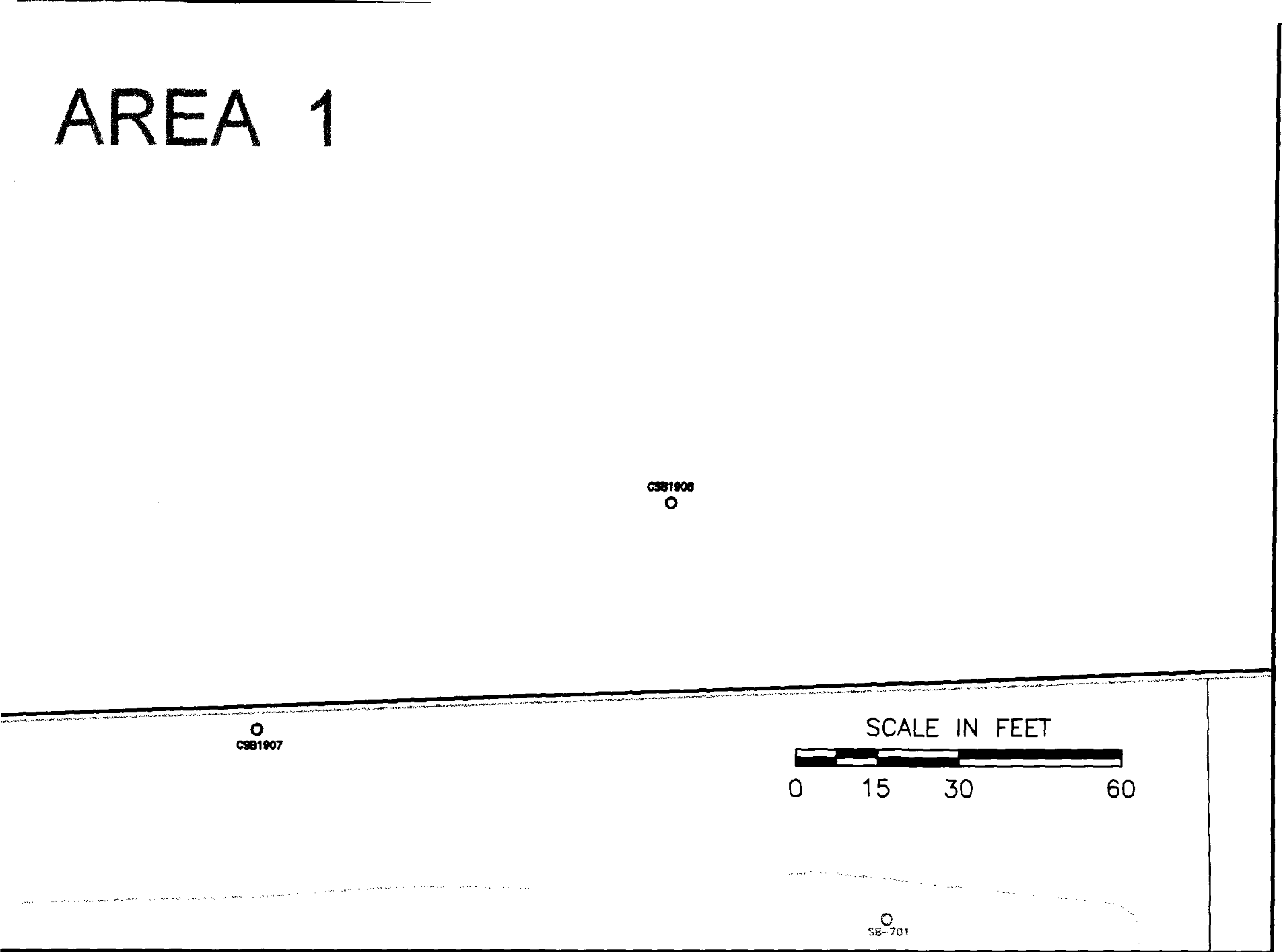


TRANS-1,2-DCE DELINEATION MAP
UPPER TILL/FILL IN AREAS 1 & 2

THE LOCKFORMER COMPANY
711 W. OGDEN AVENUE
LISLE, ILLINOIS

FIGURE

2.2-3

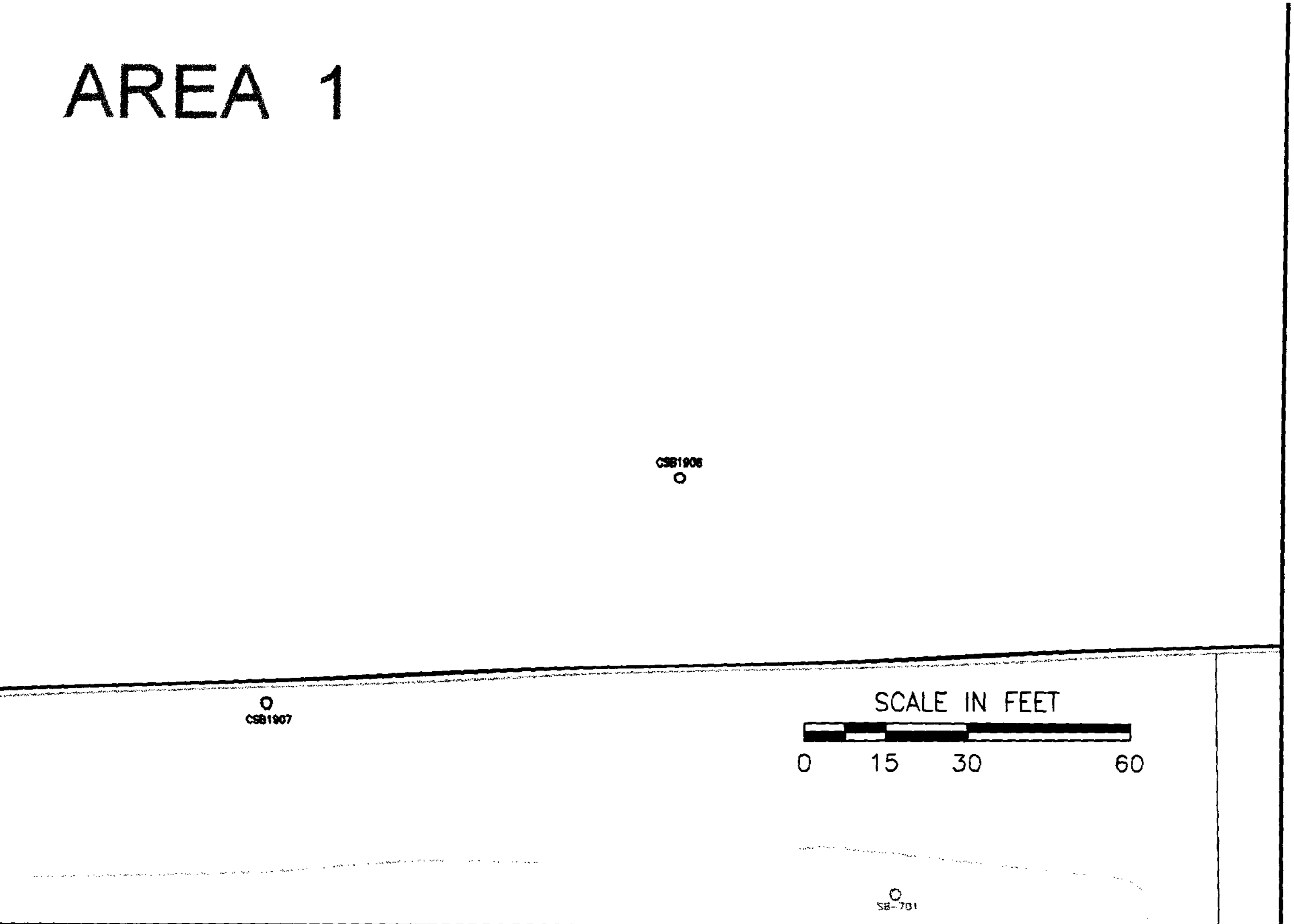


TCE DELINEATION MAP
UPPER TILL/FILL IN AREAS 1 & 2

THE LOCKFORMER COMPANY
711 W. OGDEN AVENUE
LISLE, ILLINOIS

FIGURE

2.2-4

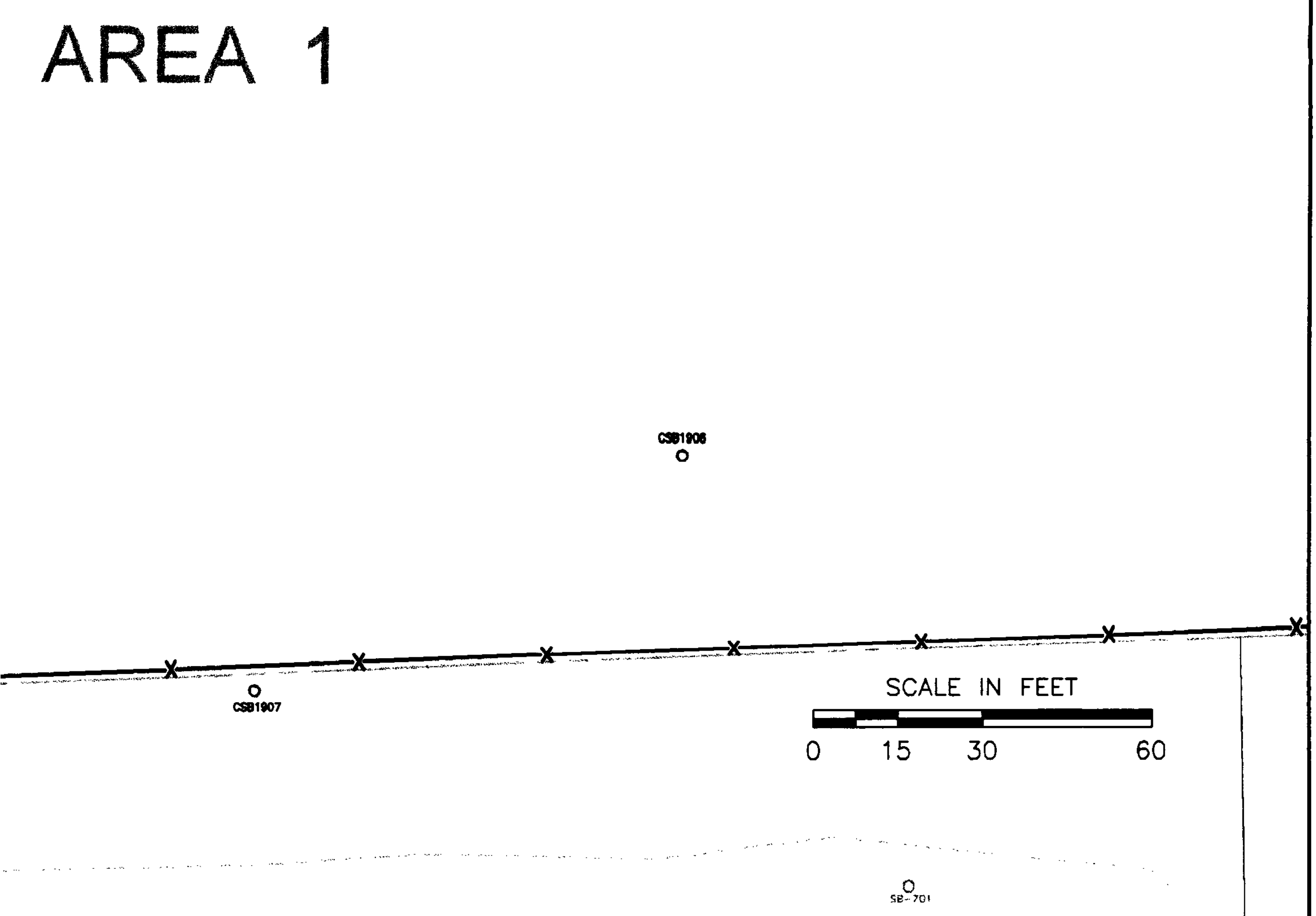


PCE DELINEATION MAP
UPPER TILL/FILL IN AREAS 1 & 2

THE LOCKFORMER COMPANY
711 W. OGDEN AVENUE
LISLE, ILLINOIS

FIGURE

2.2-5

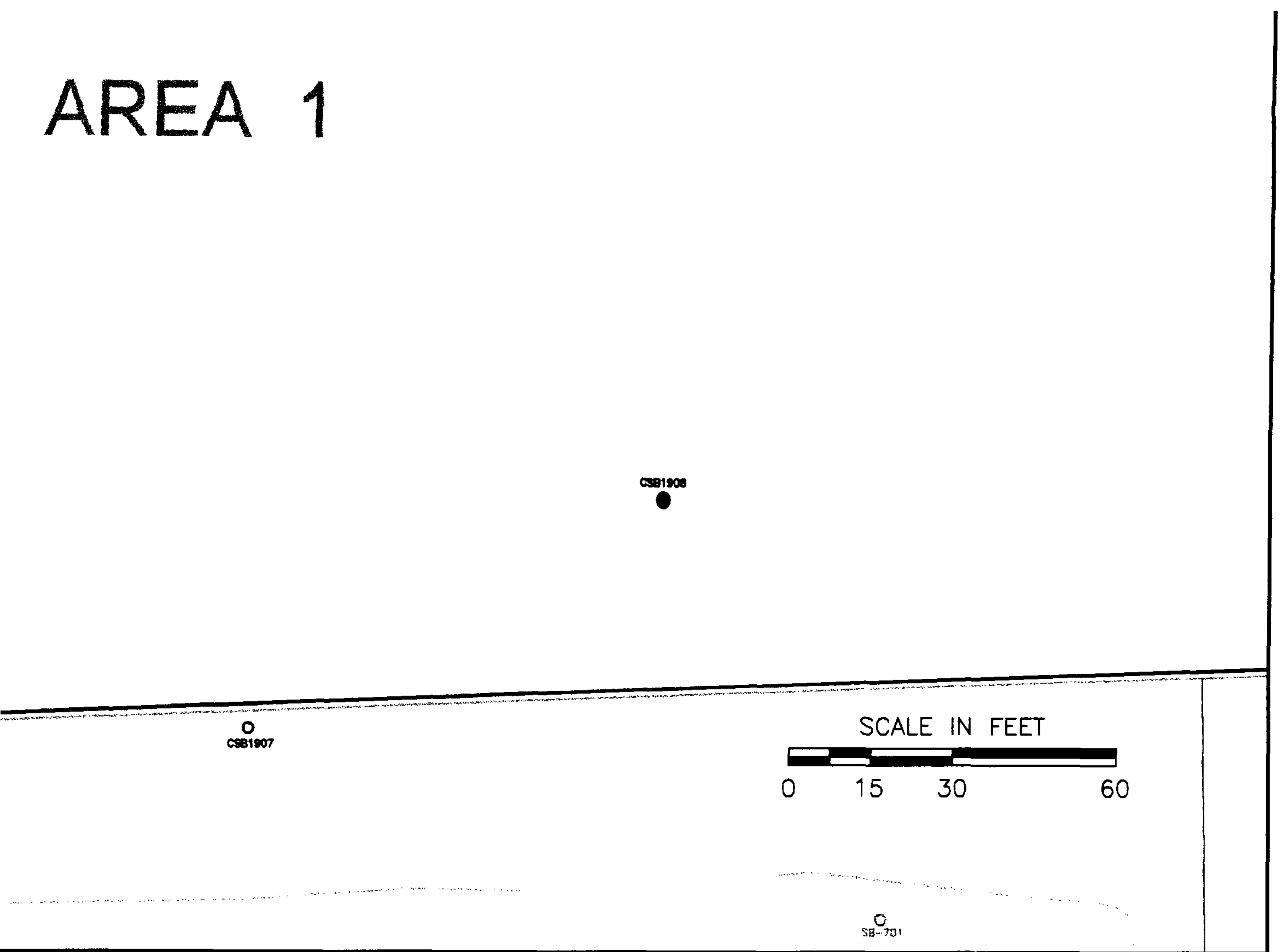


1,1,1-TCA DELINEATION MAP
UPPER TILL/FILL IN AREAS 1 & 2

THE LOCKFORMER COMPANY
711 W. OGDEN AVENUE
LISLE, ILLINOIS

FIGURE

2.2-6

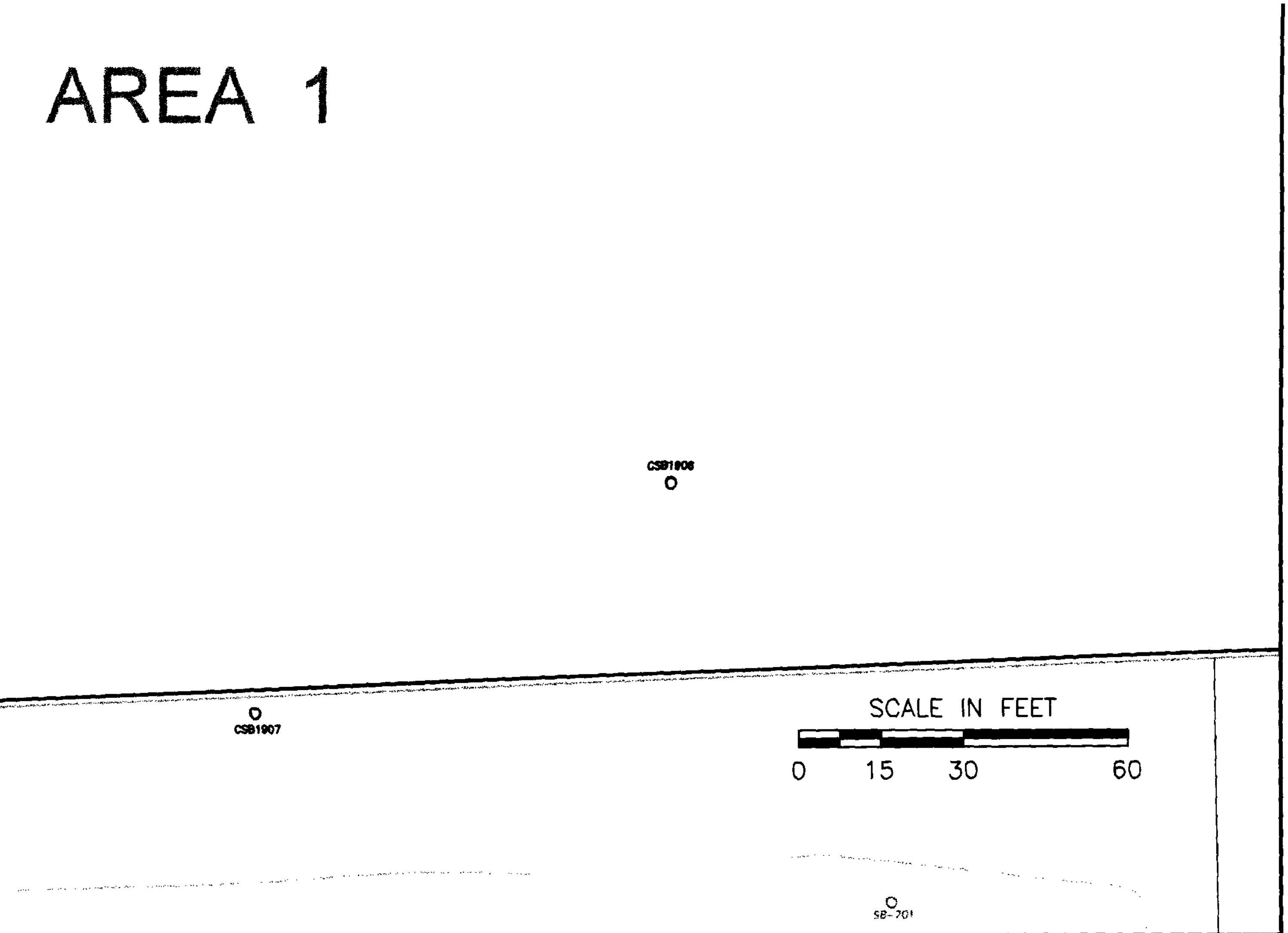


VINYL CHLORIDE DELINEATION MAP
UPPER TILL/FILL IN AREAS 1 & 2

THE LOCKFORMER COMPANY
711 W. OGDEN AVENUE
LISLE, ILLINOIS

FIGURE

2.2-7

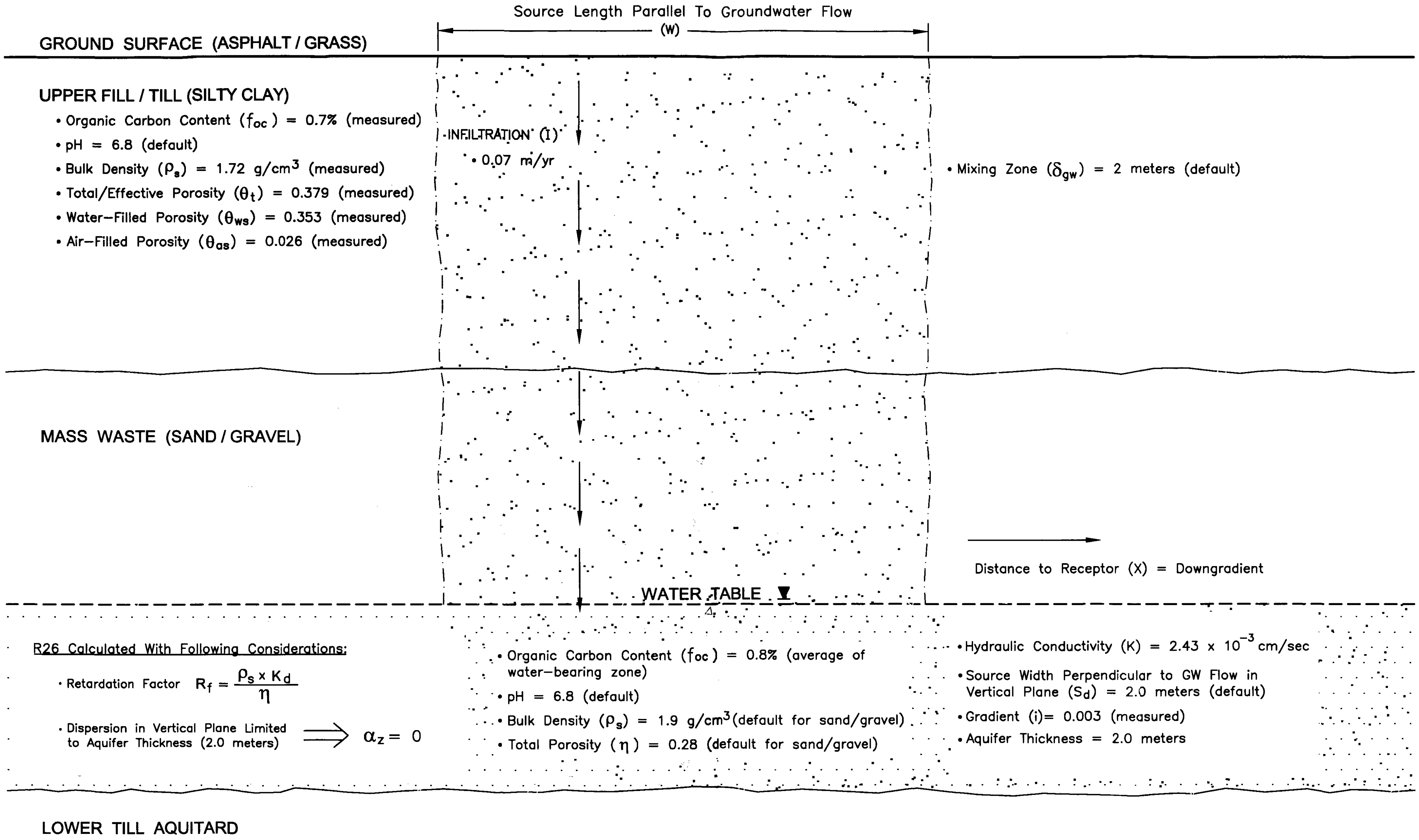


TOLUENE DELINEATION MAP
UPPER TILL/FILL IN AREAS 1 & 2

THE LOCKFORMER COMPANY
711 W. OGDEN AVENUE
LISLE, ILLINOIS

FIGURE

2.2-8



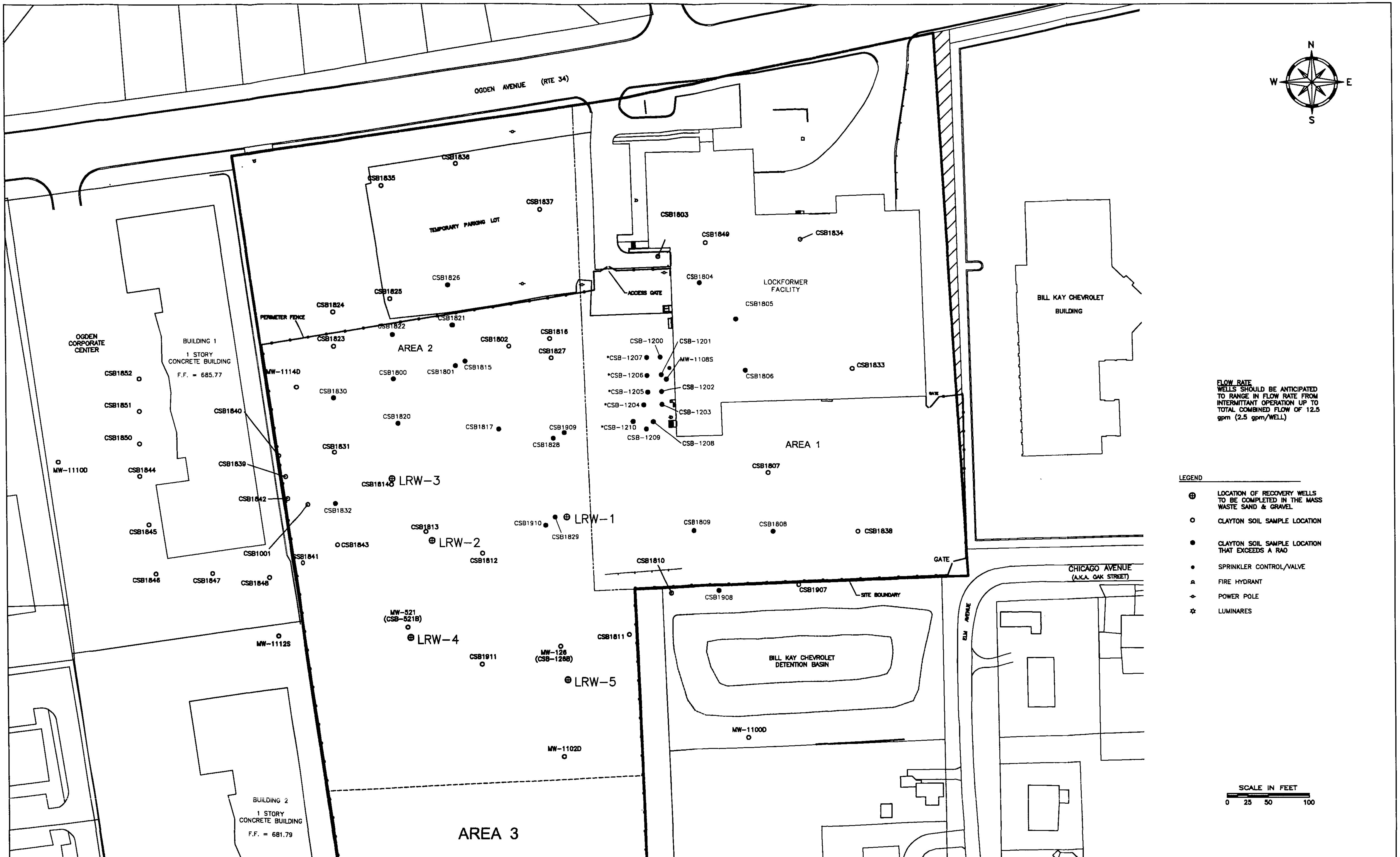
CHECK BY	
DRAWN BY	BCP
DATE	7–7–03
SCALE	AS SHOWN
CAD NO.	65263007A
PRJ NO.	65263.04

GRAPHIC MODEL PROFILE

THE LOCKFORMER COMPANY
711 W. OGDEN AVENUE
LISLE, ILLINOIS

Clayton GROUP SERVICES

FIGURE 2.2–9

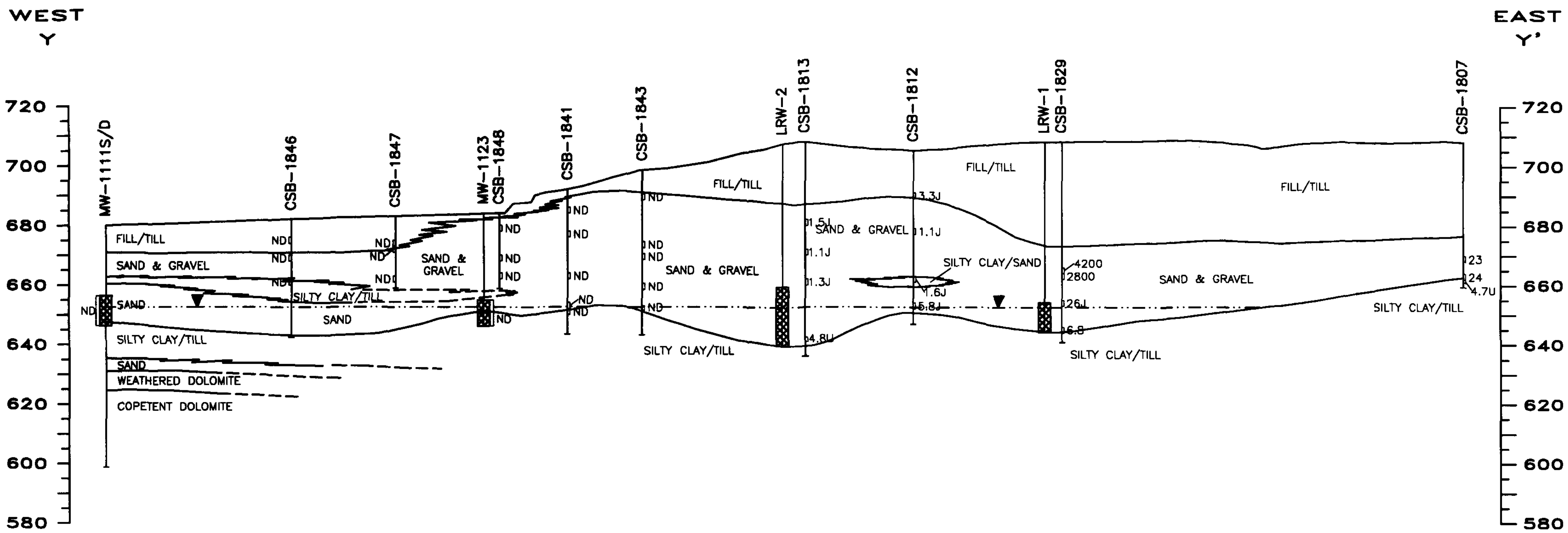


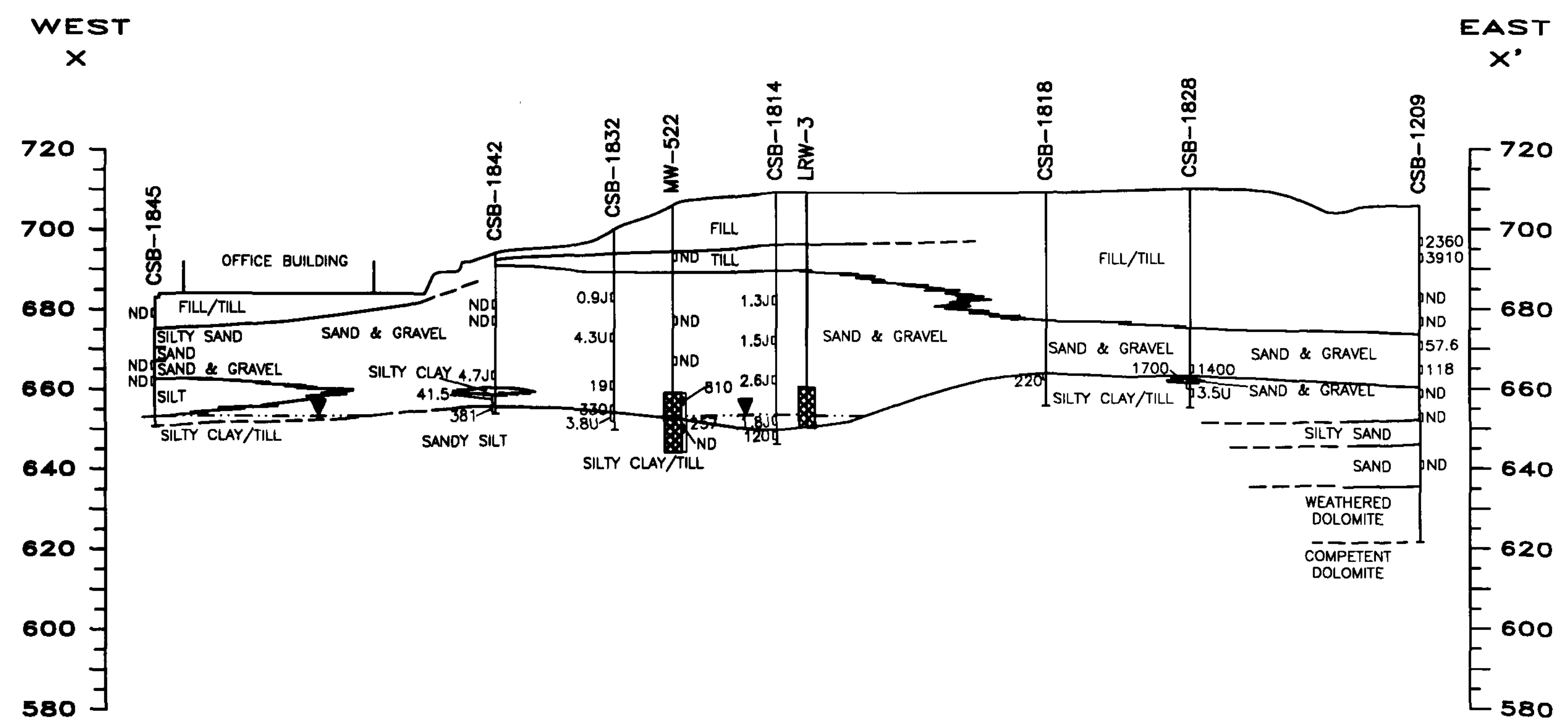
DESIGN BY:	
CHECKED BY:	
DRAWN BY:	BCP
DATE:	07-02-03
SCALE:	AS SHOWN
CAD NO.:	65263016W
PROJECT NO.:	65263.01-014

Clayton GROUP SERVICES

LOCATION OF GROUNDWATER CONTAINMENT SYSTEM RECOVERY WELLS IN AREAS 1 & 2
THE LOCKFORMER COMPANY
711 W. OGDEN AVENUE
LISLE, ILLINOIS

FIGURE 3.3-1





LEGEND

▼ APPROXIMATE POSITION OF WATER TABLE IN THE MASS WASTE UNIT SAND & GRAVEL ON NOV. 8, 2002

SCREEN INTERVAL AND TCE CONCENTRATION DETERMINED IN GROUND WATER (2003)

] 118 TCE CONCENTRATION IN ug/kg

HORIZONTAL: SCALE IN FEET
0 30 60 120

VERTICAL EXAGGERATION = 2X

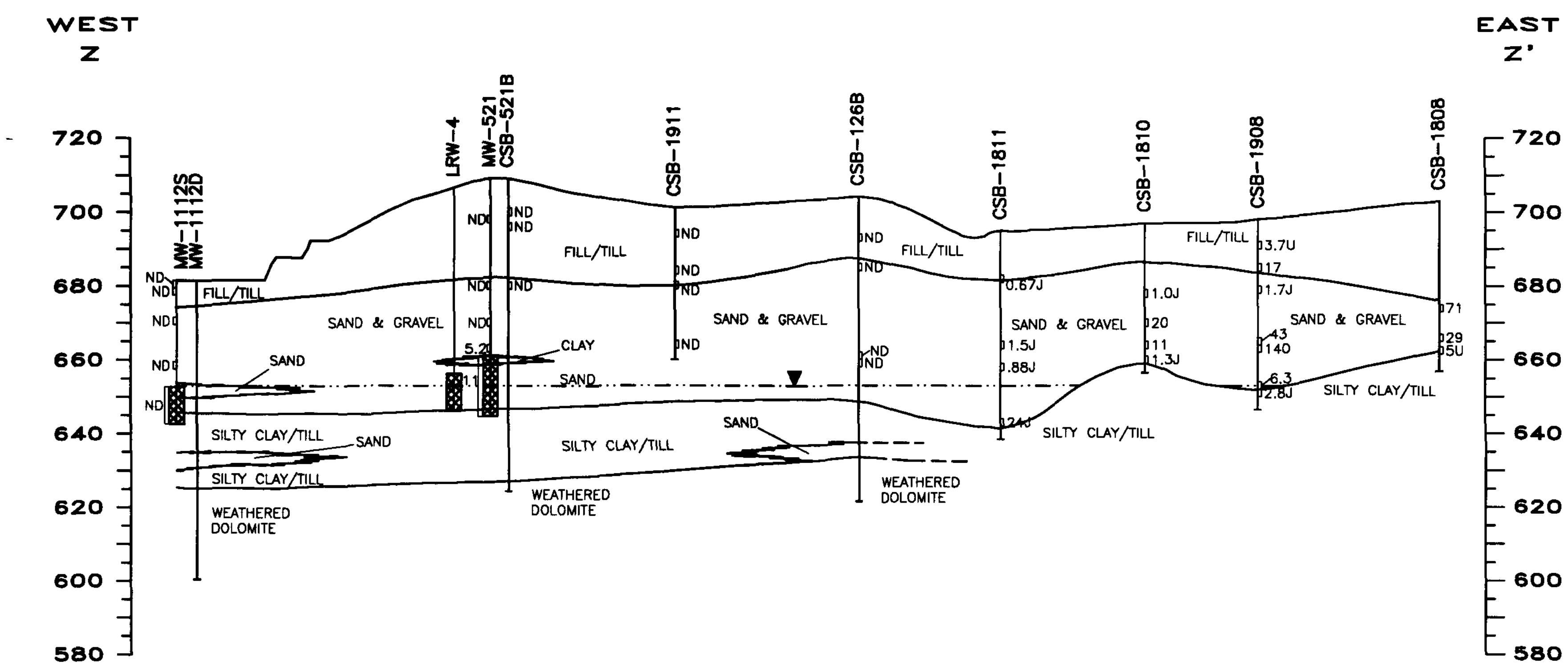
CHECK BY	JLP
DRAWN BY	JB
DATE	07-02-03
SCALE	AS SHOWN
CAD NO.	6526316T
PRJ NO.	65263.01

CROSS SECTIONS FOR GROUNDWATER CONTAINMENT SYSTEM RECOVERY WELLS #1,2 & 3

THE LOCKFORMER COMPANY
711 W. OGDEN AVENUE
LISLE, ILLINOIS

Clayton GROUP SERVICES

FIGURE 3.3-2



LEGEND

▼	APPROXIMATE POSITION OF WATER TABLE IN THE MASS WASTE UNIT SAND & GRAVEL ON NOV. 8, 2002
▩	SCREEN INTERVAL AND TCE CONCENTRATION DETERMINED IN GROUND WATER (2003)
] 118	TCE CONCENTRATION IN ug/kg

HORIZONTAL:
SCALE IN FEET
0 30 60 120
VERTICAL EXAGGERATION = 2X

CHECK BY	JLP
DRAWN BY	JB
DATE	07-02-03
SCALE	AS SHOWN
CAD NO.	6526316T
PRJ NO.	65263.01

CROSS SECTION FOR GROUNDWATER CONTAINMENT SYSTEM RECOVERY WELL #4

THE LOCKFORMER COMPANY
711 W. OGDEN AVENUE
LISLE, ILLINOIS

Clayton GROUP SERVICES

FIGURE 3.3-3

TABLES

TABLE 2.2-1
Summary of Delineation Objectives
Upper Till/Fill in Areas 1 and 2

The Lockformer Company / Lisle, Illinois

Compound	Delineation Objective (mg/kg)
Acetone	16
Benzene	0.03
Bromodichloromethane	0.6
Bromoform	0.8
Bromomethane	0.2
2-Butanone	NE
Carbon disulfide	9
Carbon tetrachloride	0.07
Chlorobenzene	1
Chlorodibromomethane	0.4
Chloroethane	NE
Chloroform	0.3
Chloromethane	NE
1,1-Dichloroethane	23
1,2-Dichloroethane	0.02
1,1-Dichloroethene	0.06
cis-1,2-Dichloroethene	0.4
trans-1,2-Dichloroethene	0.7
1,2-Dichloropropane	0.03
cis-1,3-Dichloropropene trans-1,3-Dichloropropene	0.004
Ethylbenzene	13
2-Hexanone	NE
4-Methyl-2-pentanone	NE
Methylene chloride	0.02
Styrene	4
1,1,2,2-Tetrachloroethane	NE
Tetrachloroethene	0.06
Toluene	12
1,1,1-Trichloroethane	2
1,1,2-Trichloroethane	0.02
Trichloroethene	0.06
Vinyl acetate	10
Vinyl chloride	0.01
Xylenes (total)	150

NOTES:
NE = Not Established

Delineation objective based on the most conservative value contained in Appendix B, Tables A and B of 35 IAC 742.

TABLE 2.2-2
Summary of Hydraulic Conductivity Slug Testing Results
Shallow Water-Bearing Unit

The Lockformer Company / Lisle, Illinois

Well Location	Hydraulic Conductivity (K) in cm/sec	
	Falling Head	Rising Head
MW-521	2.56E-02	3.44E-02
MW-522	5.77E-04	1.12E-03
MW-1100S	6.98E-04	2.72E-04
MW-1101S	7.69E-04	7.64E-04
MW-1103S	9.69E-04	3.10E-03
MW-1109S	5.69E-04	8.15E-03
MW-1112S	7.27E-03	1.47E-02
MW-1113S	1.97E-03	1.30E-03
MW-1117	4.59E-03	7.73E-04
GEOMEAN	**2.43E-03**	

NOTES:

Hydraulic conductivity analysis conducted using Bower and Rice.

TABLE 2.2-3
Soil Remediation Objective Comparison Table
Upper Till/Fill in Areas 1 and 2

The Lockformer Company / Lisle, Illinois

Compound of Concern		Calculated SRO	Existing Soil RAO	Soil Component of the GWRO
cis-1,2-Dichloroethene				
	Area 1	176.364	1,200	176.364
	Area 2	10.273	1,200	10.273
	Degreaser	27.909	1,200	27.909
trans-1,2-Dichloroethene				
	Area 1	697.917	3,100	697.917
	Degreaser	80.787	3,100	80.787
Tetrachloroethene				
	Area 1	260	20	20
	Area 2	260	20	20
	Degreaser	260	20	20
Trichloroethene				
	Area 1	1,510	8.9	8.9
	Area 2	357	8.9	8.9
	Degreaser	1,197	8.9	8.9
1,1,1-Trichloroethane				
	Area 1 (NW)	1,310	1,200	1,200
	Area 1 (SW)	1,310	1,200	1,200
Vinyl Chloride				
	Area 1	1.41	1.1	1.1
	Area 2	0.11	1.1	0.11
	Degreaser	0.195	1.1	0.195
Toluene				
	Area 1	780	650	650

NOTES: Values expressed in mg/kg
RAO = Removal Action Objective
GWRO = Groundwater Remediation Objective
SRO = Soil Remediation Objective (soil component of the groundwater ingestion route)

APPENDIX A

BORING LOGS

Clayton GROUP SERVICES

BORING NO: CSB1850	PROJECT NO: 15-65263.03-001	PROJECT NAME: Lockformer Lisle, IL
BORING LOCATION: Ogden Corporate Center		COORDINATES:
DRILLING CO: Mid-America Drilling		DRILLER: J. Zils
DRILLING EQUIP: Bobcat Geoprobe		BOREHOLE DIA: 2"
START DATE: 6/7/2003	FINISH DATE: 6/7/2003	LOGGED BY: D. Lamsma
START TIME (hours): 0710	FINISH TIME (hours): 0805	CHECKED BY:

DEPTH (ft)	DESCRIPTION	GRAPHIC	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES METHOD	SAMPLES MOISTURE	SAMPLES BLOW CNT (6")	PID SCAN	PID HEADSPACE	REMARKS
0–2	ASPHALT FILL Gravel, gray, moist			2/2	HPU	M		0.6	0.2	
2–4	SILTY CLAY (CL) Brown, moist, stiff Some fine sand from 3.0 to 4.0 feet			2/2	HPH	M		0.5	0.2	
4–6	SAND (SP) Brown, moist, fine to medium grained			2/2	HPU	M		0.1	0.2	
6–8				2/2	HPU	M		0.1	0.5	
8–10	SILTY SAND (SM) Tan, moist, some clay, slightly cohesive			2/2	HPU	M		0.1	0.5	
10–12	SAND (SW) Brown, moist, fine to coarse grained, trace gravel up to 2"			2/2	HPU	M		0.1	0.5	
12–14	SAND AND GRAVEL (GW) Brown, moist, fine to coarse sand, gravel up to 1"			1.5/2	HPU	M		0.1	0.7	
14–16				1.5/2	HPU	M		0.1	0.9	
16–18	Some silt from 16.0 to 22.0 feet			1.5/2	HPU	M		0	1.3	VOCs
18–20				1.5/2	HPU	M		0	1	

Clayton GROUP SERVICES

BORING NO: CSB1850	PROJECT NO: 15-65263.03-001	PROJECT NAME: Lockformer Lisle, IL

DEPTH	DESCRIPTION	GRAPHIC	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES METHOD	SAMPLES MOISTURE	SAMPLES BLOW CNT (6")	PID SCAN	PID HEADSPACE	REMARKS
20–22				1.5/2	HPU	M		0	0.2	
22–24	**SILTY CLAY (CL)** Gray, moist, some fine to medium sand, trace gravel, stiff, cohesive			1.5/2	HPU	M		0	0.1	VOCs
24–26	**SAND AND GRAVEL (GW)** Brown, moist, fine to coarse sand, gravel up to 1"			1.5/2	HPU	M		0	0.1	
26–28				1.5/2	HPU	M/VM		0	0.1	
28–30	**SILTY SAND (SM)** Brown, very moist, trace clay, soft Wet at 28.0 feet			1/2	HPU	W		–	–	
30–32				1/2	HPU	W		–	–	
32	End of Boring at 32.0 Feet									

Clayton GROUP SERVICES

BORING NO: CSB1851	PROJECT NO: 15-65263.03-001	PROJECT NAME: Lockformer Lisle, IL
BORING LOCATION: Ogden Corporate Center		COORDINATES:
DRILLING CO: Mid-America Drilling		DRILLER: J. Zils
DRILLING EQUIP: Bobcat Geoprobe		BOREHOLE DIA: 2"
START DATE: 6/7/2003	FINISH DATE: 6/7/2003	LOGGED BY: D. Lamsma
START TIME (hours): 0835	FINISH TIME (hours): 0939	CHECKED BY:

DEPTH (ft)	DESCRIPTION	GRAPHIC	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES METHOD	SAMPLES MOISTURE	SAMPLES BLOW CNT (6")	PID SCAN	PID HEADSPACE	REMARKS
0–2	**ASPHALT** **FILL** Gravel, gray, moist			2/2	HPU	M		0	0.9	
2–4	**SILTY CLAY (CL)** Dark brown, moist, some medium to coarse sand, stiff **SAND (SP)** Brown, moist, fine to medium grained			2/2	HPU	M		0	1.8	
4–6				2/2	HPU	M		0	1	
6–8				2/2	HPU	M		0	1.4	
8–10	**SILT (ML)** Light brown, moist, trace fine sand and clay, soft **SAND (SW)** Brown, moist, fine to coarse grained, trace gravel			1/2	HPU	M		0	0.6	
10–12				1/2	HPU	M		0	1.4	
12–14	**SAND AND GRAVEL (GW)** Brown, moist, fine to coarse sand, gravel up to 2", some silt and clay			2/2	HPU	M		0	0.5	
14–16				2/21/2	HPU	M		0	1	
16–18				1/2	HPU	M		0	2.8	VOCs
18–20				1/2	HPU	M		0	2.1	

Clayton GROUP SERVICES

BORING NO: CSB2221	PROJECT NO: 15-65263.03-001	PROJECT NAME: Lockformer Lisle, IL
BORING LOCATION: Area 1; south of the Lockformer Facility		COORDINATES:
DRILLING CO: Mid America Drilling		DRILLER: J. Luna
DRILLING EQUIP: Truck Mounted Geoprobe		BOREHOLE DIA: 2"
START DATE: 6/20/03	FINISH DATE: 6/20/03	LOGGED BY: D.frieling
START TIME (hours): 0855	FINISH TIME (hours): 0915	CHECKED BY:

DEPTH (ft)	DESCRIPTION	GRAPHIC	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES METHOD	SAMPLES MOISTURE	SAMPLES BLOW CNT (6")	PID SCAN	PID HEADSPACE	REMARKS
0–2	FILL Sand, black, fine to coarse, some silt FILL Silty clay, dusky, moist, with some fine to medium sand and fine gravel, cohesive			1.8/2	HPU	M	--	0	1.2	
2–4	Concrete pieces from 2.8 to 3.1 feet			1.8/2	HPU	M	--	0	5.2	VOCs
4–6	Some roots and wire pieces from 3.9 to 5.1 feet Grades brown at 5.1 feet			2/2	HPU	M	--	0	1.7	
6–8	SILTY CLAY (CL) Brown, moist, grey mottles, trace fine gravel, some fine to medium sand			2/2	HPU	M	--	0	2.6	
8–10				1.8/2	HPU	M	--	0	1.3	
10–12				1.8/2	HPU	M	--	0	2.3	
12	End of boring at 12.0 feet									

Clayton GROUP SERVICES

BORING NO: CSB2222	PROJECT NO: 15-65263.03.001	PROJECT NAME: Lockformer Lisle, IL
BORING LOCATION: Area 1; south of the Lockformer Facility		COORDINATES:
DRILLING CO: Mid America Drilling		DRILLER: J. Luna
DRILLING EQUIP: Truck Mounted Geoprobe		BOREHOLE DIA: 2"
START DATE: 6/20/03	FINISH DATE: 6/20/03	LOGGED BY: D.Frieling
START TIME (hours): 0925	FINISH TIME (hours): 0950	CHECKED BY:

DEPTH (ft)	DESCRIPTION	GRAPHIC	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES METHOD	SAMPLES MOISTURE	SAMPLES BLOW CNT (6")	PID SCAN	PID HEADSPACE	REMARKS
0–2	FILL Silty clay, dusky, moist, with some fine to medium sand and fine gravel, cohesive			1.6/2	HPU	M	--	0	1.4	
2–4	Grades brown at 3.1 feet			1.6/2	HPU	M	--	0	1.7	
4–6				1.9/2	HPU	M	--	0	1.9	VOCs
6–8	SILTY CLAY (CL) Brown, moist, grey mottles, trace fine gravel, some fine to medium sand			1.9/2	HPU	M	--	0	1.5	
8–10				2/2	HPU	M	--	0	1.8	
10–12				2/2	HPU	M	--	0	1.1	
12	End of boring at 12.0 feet									

Clayton GROUP SERVICES

BORING NO: CSB2223	PROJECT NO: 15-65263.03-001	PROJECT NAME: Lockformer Lisle, IL
BORING LOCATION: Area 1; south of the Lockformer Facility		COORDINATES:
DRILLING CO: Mid America Drilling	DRILLER: J. Luna	
DRILLING EQUIP: Truck Mounted Geoprobe	BOREHOLE DIA: 2"	
START DATE: 6/20/03	FINISH DATE: 6/20/03	LOGGED BY: D.Frieling
START TIME (hours): 1005	FINISH TIME (hours): 1035	CHECKED BY:

DEPTH (ft)	DESCRIPTION	GRAPHIC	SAMPLES NUMBER	RECOVERY	METHOD	MOISTURE	BLOW CNT (6")	PID SCAN	PID HEADSPACE	REMARKS
0–2	FILL Gravel FILL Silty clay, dusky, moist, with some fine to coarse sand and fine gravel, cohesive, trace roots			1.5/2	HPU	M	--	0	0.4	
2–4				1.6/2	HPU	M	--	0	0.7	
4–6				1.9/2	HPU	M/W	--	0	1.2	
6–8	Wet from 5.8 to 6.1 feet SILTY CLAY (CL) Brown, moist, grey mottles, trace fine gravel, some fine to medium sand			1.9/2	HPU	M	--	0	1.4	VOCs
8–10				2/2	HPU	M	--	0	1.0	
10–12				2/2	HPU	M	--	0	0.8	
12	End of boring at 12.0 feet									

Clayton
GROUP SERVICES

BORING NO: CSB2224	PROJECT NO: 15-65263.03-001	PROJECT NAME: Lockformer Lisle, IL
BORING LOCATION: Area 1; south of the Lockformer Facility		COORDINATES:
DRILLING CO: Mid America Drilling		DRILLER: J. Luna
DRILLING EQUIP: Truck Mounted Geoprobe		BOREHOLE DIA: 2"
START DATE: 6/20/03	FINISH DATE: 6/20/03	LOGGED BY: D. Frieling
START TIME (hours): 1100	FINISH TIME (hours): 1112	CHECKED BY:

DEPTH (ft)	DESCRIPTION	GRAPHIC	SAMPLES: NUMBER	SAMPLES: RECOVERY	SAMPLES: METHOD	SAMPLES: MOISTURE	SAMPLES: BLOW CNT (6")	PID: SCAN	PID: HEADSPACE	REMARKS
0–2	FILL Sand, black, fine to coarse, some silt			1.4/2	HPU	M	--	0	0	
2–4	FILL Silty clay, dusky, moist, with some fine to medium sand and fine gravel, cohesive, wood pieces			1.5/2	HPU	M	--	0	0.7	
4–6	Grades brown at 3.8 feet			2/2	HPU	M	--	0	1.8	
6–8	SILTY CLAY (CL) Brown, moist, grey mottles, trace fine gravel			2/2	HPU	M	--	0	1.2	
8–10				1.6/2	HPU	M	--	0	1.9	VOCs
10–12				1.6/2	HPU	M	--	0	0.7	
12	End of boring at 12.0 feet									

Clayton GROUP SERVICES

BORING NO: CSB2225	PROJECT NO: 15-65263.03-001	PROJECT NAME: Lockformer Lisle, IL
BORING LOCATION: Area 1; south of the Lockformer Facility		COORDINATES:
DRILLING CO: Mid America Drilling	DRILLER: J. Luna	
DRILLING EQUIP: Truck Mounted Geoprobe	BOREHOLE DIA: 2"	
START DATE: 6/20/03	FINISH DATE: 6/20/03	LOGGED BY: D. Frieling
START TIME (hours): 1135	FINISH TIME (hours): 1150	CHECKED BY:

DEPTH (ft)	DESCRIPTION	GRAPHIC	SAMPLES: NUMBER	RECOVERY	METHOD	MOISTURE	BLOW CNT (6")	PID: SCAN	HEADSPACE	REMARKS
0–2	FILL Gravel FILL Silty clay, dusky, moist, with some fine to coarse sand and fine gravel, cohesive, trace roots and wood pieces			1.9/2	HPU	M	--	0	0.4	
2–4				1.9/2	HPU	M	--	0	0.4	
4–6	Grades brown at 3.8 feet			2/2	HPU	M	--	0	0.6	
6–8	SILTY CLAY (CL) Brown, moist, grey mottles, trace fine gravel, some fine to medium sand			2/2	HPU	M	--	0	2.9	
8–10				2/2	HPU	M	--	0	10.3	VOCs
10–12				2/2	HPU	M	--	0	4.2	
12	End of boring at 12.0 feet									

Clayton
GROUP SERVICES

APPENDIX B

SUMMARY OF REMEDIAL ALTERNATIVE COST ESTIMATES
AREAS 1 AND 2

Summary of Remedial Alternative Cost Estimates
Areas 1 & 2 Groundwater - Lockformer -- Lisle, IL

Summary

Alternative 1: Permeable Reactive Barrier	$ 3,997,771
Alternative 2: Biological Treatment of Groundwater	$ 1,244,803
Alternative 3: Groundwater Containment	$ 1,287,803
Alternative 4: No Action	$ 351,328

Remedial Alternative Cost Estimate

Areas 1 & 2 Groundwater

Lockformer - Lisle, Illinois

Alternative 1: Permeable Reactive Barrier

ITEM DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST	SUBTOTAL
ADDITIONAL SITE TESTING					
Additional Geochemical Testing					
Soil and Groundwater Sampling/Analysis	1	LS	$ 30,000	$ 30,000	
Bench-Scale Testing	1	LS	$ 47,000	$ 47,000	
Pilot Scale Testing	1	LS	$ 140,000	$ 140,000	$ 217,000
BARRIER INSTALLATION					
Iron	1	LS	$ 1,435,000	$ 1,435,000	
License Fee	1	LS	$ 194,000	$ 194,000	
Emplacement	1	LS	$ 870,000	$ 870,000	
Survey	1	LS	$ 1,500	$ 1,500	
Performance Monitoring Well Installation	1	LS	$ 24,000	$ 24,000	$ 2,524,500
CONSTRUCTION SUBTOTAL					**$ 2,741,500**
OTHER DIRECT COSTS					
ENGINEERING & DESIGN	1	LS	$ 246,735		$ 246,735
PERMITTING	1	LS	$ 54,830		$ 54,830
HEALTH & SAFETY	1	LS	$ 54,830		$ 54,830
CONSTRUCTION OVERSIGHT	1	LS	$ 82,245		$ 82,245
CONTINGENCIES	1	LS	$ 137,075		$ 137,075
CLOSURE/DECOMMISSIONING	1	LS	$ 54,830		$ 54,830
TOTAL CAPITAL COST					**$ 3,372,045**
ANNUAL OPERATION & MAINTENANCE (for 30 years)					
Quarterly Monitoring/Reporting	1	YR	$ 30,000	$ 30,000	(Present Value)
Biannual Monitoring/Reporting	29	YR	$ 20,000	$ 302,821	
Well Cleaning/Replacement (every 10 years)	3	EA	$ 15,000	$ 18,506	
PRB System Performance Monitoring	30	YR	$ 17,000	$ 274,398	$ 625,726
GRAND TOTAL COST					**$ 3,997,771**

Note: All O&M Costs are in Net Present Value unless otherwise noted.

Net Present Value Calculations
Alternative 1 - Permeable Reactive Barrier

Biannual Monitoring/Reporting

Year	Payment	Discount Factor	Present Value
1	$ 20,000	0.9524	$ 19,047.62
2	$ 20,000	0.9070	$ 18,140.59
3	$ 20,000	0.8638	$ 17,276.75
4	$ 20,000	0.8227	$ 16,454.05
5	$ 20,000	0.7835	$ 15,670.52
6	$ 20,000	0.7462	$ 14,924.31
7	$ 20,000	0.7107	$ 14,213.63
8	$ 20,000	0.6768	$ 13,536.79
9	$ 20,000	0.6446	$ 12,892.18
10	$ 20,000	0.6139	$ 12,278.27
11	$ 20,000	0.5847	$ 11,693.59
12	$ 20,000	0.5568	$ 11,136.75
13	$ 20,000	0.5303	$ 10,606.43
14	$ 20,000	0.5051	$ 10,101.36
15	$ 20,000	0.4810	$ 9,620.34
16	$ 20,000	0.4581	$ 9,162.23
17	$ 20,000	0.4363	$ 8,725.93
18	$ 20,000	0.4155	$ 8,310.41
19	$ 20,000	0.3957	$ 7,914.68
20	$ 20,000	0.3769	$ 7,537.79
21	$ 20,000	0.3589	$ 7,178.85
22	$ 20,000	0.3418	$ 6,837.00
23	$ 20,000	0.3256	$ 6,511.43
24	$ 20,000	0.3101	$ 6,201.36
25	$ 20,000	0.2953	$ 5,906.06
26	$ 20,000	0.2812	$ 5,624.81
27	$ 20,000	0.2678	$ 5,356.97
28	$ 20,000	0.2551	$ 5,101.87
29	$ 20,000	0.2429	$ 4,858.93

NET PRESENT VALUE $ 302,821.47

Well Cleaning/Replacement (every 10 years)

Year	Payment	Discount Factor	Present Value
1		0.9524	$ -
2		0.9070	$ -
3		0.8638	$ -
4		0.8227	$ -
5		0.7835	$ -
6		0.7462	$ -
7		0.7107	$ -
8		0.6768	$ -
9		0.6446	$ -
10	$ 15,000	0.6139	$ 9,208.70
11		0.5847	$ -
12		0.5568	$ -
13		0.5303	$ -
14		0.5051	$ -
15		0.4810	$ -
16		0.4581	$ -
17		0.4363	$ -
18		0.4155	$ -
19		0.3957	$ -
20	$ 15,000	0.3769	$ 5,653.34
21		0.3589	$ -
22		0.3418	$ -
23		0.3256	$ -
24		0.3101	$ -
25		0.2953	$ -
26		0.2812	$ -
27		0.2678	$ -
28		0.2551	$ -
29	$ 15,000	0.2429	$ 3,644.19

NET PRESENT VALUE $ 18,506.24

Net Present Value Calculations
Alternative 1 - Permeable Reactive Barrier

PRB System Performance Monitoring

Year	Payment	Discount Factor	Present Value
1	$ 17,000	0.9524	$ 16,190.48
2	$ 17,000	0.9070	$ 15,419.50
3	$ 17,000	0.8638	$ 14,685.24
4	$ 17,000	0.8227	$ 13,985.94
5	$ 17,000	0.7835	$ 13,319.94
6	$ 17,000	0.7462	$ 12,685.66
7	$ 17,000	0.7107	$ 12,081.58
8	$ 17,000	0.6768	$ 11,506.27
9	$ 17,000	0.6446	$ 10,958.35
10	$ 17,000	0.6139	$ 10,436.53
11	$ 17,000	0.5847	$ 9,939.55
12	$ 17,000	0.5568	$ 9,466.24
13	$ 17,000	0.5303	$ 9,015.46
14	$ 17,000	0.5051	$ 8,586.16
15	$ 17,000	0.4810	$ 8,177.29
16	$ 17,000	0.4581	$ 7,787.90
17	$ 17,000	0.4363	$ 7,417.04
18	$ 17,000	0.4155	$ 7,063.85
19	$ 17,000	0.3957	$ 6,727.48
20	$ 17,000	0.3769	$ 6,407.12
21	$ 17,000	0.3589	$ 6,102.02
22	$ 17,000	0.3418	$ 5,811.45
23	$ 17,000	0.3256	$ 5,534.71
24	$ 17,000	0.3101	$ 5,271.15
25	$ 17,000	0.2953	$ 5,020.15
26	$ 17,000	0.2812	$ 4,781.09
27	$ 17,000	0.2678	$ 4,553.42
28	$ 17,000	0.2551	$ 4,336.59
29	$ 17,000	0.2429	$ 4,130.09
		NET PRESENT VALUE	**$ 257,398.25**

Remedial Alternative Cost Estimate

Areas 1 & 2 Groundwater
Lockformer - Lisle, Illinois

Alternative 2: Biological Treatment of Groundwater

ITEM DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST	SUBTOTAL
ADDITIONAL SITE TESTING					
Additional Geochemical Testing					
Soil and Groundwater Sampling/Analysis	1	LS	$ 22,000	$ 22,000	
Bench-Scale Testing	1	LS	$ 42,000	$ 42,000	
Pilot Scale Testing	1	LS	$ 61,000	$ 61,000	$ 125,000
SYSTEM INSTALLATION					
Biological Treatment Equipment	1	LS	$ 70,000	$ 70,000	
Survey	1	LS	$ 1,500	$ 1,500	
Well Installation and Piping	1	LS	$ 45,000	$ 45,000	$ 116,500
CONSTRUCTION SUBTOTAL					**$ 241,500**
OTHER DIRECT COSTS					
ENGINEERING & DESIGN	1	LS	$ 173,880		$ 173,880
PERMITTING	1	LS	$ 24,150		$ 24,150
HEALTH & SAFETY	1	LS	$ 12,075		$ 12,075
CONSTRUCTION OVERSIGHT	1	LS	$ 48,300		$ 48,300
CONTINGENCIES	1	LS	$ 36,225		$ 36,225
CLOSURE/DECOMMISSIONING	1	LS	$ 48,300		$ 48,300
TOTAL CAPITAL COST					**$ 584,430**
ANNUAL OPERATION & MAINTENANCE (for 30 years)					(Present Value)
Quarterly Monitoring/Reporting	1	YR	$ 30,000	$ 30,000	
Biannual Monitoring/Reporting	29	YR	$ 20,000	$ 302,821	
Well Cleaning/Replacement (every 10 years)	3	EA	$ 15,000	$ 18,506	
Injection Well Cleaning/Replacement (every 10 years)	3	EA	$ 15,000	$ 18,506	
System Operation/Periodic Maintenance	30	YR	$ 18,000	$ 290,539	$ 660,373
GRAND TOTAL COST					**$ 1,244,803**

Note: All O&M Costs are in Net Present Value unless otherwise noted.

Net Present Value Calculations
Alternative 2 - Biological Treatment

Biannual Monitoring/Reporting

Year	Payment	Discount Factor	Present Value
1	$ 20,000	0.9524	$ 19,047.62
2	$ 20,000	0.9070	$ 18,140.59
3	$ 20,000	0.8638	$ 17,276.75
4	$ 20,000	0.8227	$ 16,454.05
5	$ 20,000	0.7835	$ 15,670.52
6	$ 20,000	0.7462	$ 14,924.31
7	$ 20,000	0.7107	$ 14,213.63
8	$ 20,000	0.6768	$ 13,536.79
9	$ 20,000	0.6446	$ 12,892.18
10	$ 20,000	0.6139	$ 12,278.27
11	$ 20,000	0.5847	$ 11,693.59
12	$ 20,000	0.5568	$ 11,136.75
13	$ 20,000	0.5303	$ 10,606.43
14	$ 20,000	0.5051	$ 10,101.36
15	$ 20,000	0.4810	$ 9,620.34
16	$ 20,000	0.4581	$ 9,162.23
17	$ 20,000	0.4363	$ 8,725.93
18	$ 20,000	0.4155	$ 8,310.41
19	$ 20,000	0.3957	$ 7,914.68
20	$ 20,000	0.3769	$ 7,537.79
21	$ 20,000	0.3589	$ 7,178.85
22	$ 20,000	0.3418	$ 6,837.00
23	$ 20,000	0.3256	$ 6,511.43
24	$ 20,000	0.3101	$ 6,201.36
25	$ 20,000	0.2953	$ 5,906.06
26	$ 20,000	0.2812	$ 5,624.81
27	$ 20,000	0.2678	$ 5,356.97
28	$ 20,000	0.2551	$ 5,101.87
29	$ 20,000	0.2429	$ 4,858.93

NET PRESENT VALUE $ 302,821.47

System Operation/Period Maintenance

Year	Payment	Discount Factor	Present Value
1	$ 18,000	0.9524	$ 17,142.86
2	$ 18,000	0.9070	$ 16,326.53
3	$ 18,000	0.8638	$ 15,549.08
4	$ 18,000	0.8227	$ 14,808.64
5	$ 18,000	0.7835	$ 14,103.47
6	$ 18,000	0.7462	$ 13,431.88
7	$ 18,000	0.7107	$ 12,792.26
8	$ 18,000	0.6768	$ 12,183.11
9	$ 18,000	0.6446	$ 11,602.96
10	$ 18,000	0.6139	$ 11,050.44
11	$ 18,000	0.5847	$ 10,524.23
12	$ 18,000	0.5568	$ 10,023.07
13	$ 18,000	0.5303	$ 9,545.78
14	$ 18,000	0.5051	$ 9,091.22
15	$ 18,000	0.4810	$ 8,658.31
16	$ 18,000	0.4581	$ 8,246.01
17	$ 18,000	0.4363	$ 7,853.34
18	$ 18,000	0.4155	$ 7,479.37
19	$ 18,000	0.3957	$ 7,123.21
20	$ 18,000	0.3769	$ 6,784.01
21	$ 18,000	0.3589	$ 6,460.96
22	$ 18,000	0.3418	$ 6,153.30
23	$ 18,000	0.3256	$ 5,860.28
24	$ 18,000	0.3101	$ 5,581.22
25	$ 18,000	0.2953	$ 5,315.45
26	$ 18,000	0.2812	$ 5,062.33
27	$ 18,000	0.2678	$ 4,821.27
28	$ 18,000	0.2551	$ 4,591.69
29	$ 18,000	0.2429	$ 4,373.03

NET PRESENT VALUE $ 272,539.32

Net Present Value Calculations
Alternative 2 - Biological Treatment

Well Cleaning/Replacement (every 10 years)

Year	Payment	Discount Factor	Present Value
1		0.9524	$ -
2		0.9070	$ -
3		0.8638	$ -
4		0.8227	$ -
5		0.7835	$ -
6		0.7462	$ -
7		0.7107	$ -
8		0.6768	$ -
9		0.6446	$ -
10	$ 15,000	0.6139	$ 9,208.70
11		0.5847	$ -
12		0.5568	$ -
13		0.5303	$ -
14		0.5051	$ -
15		0.4810	$ -
16		0.4581	$ -
17		0.4363	$ -
18		0.4155	$ -
19		0.3957	$ -
20	$ 15,000	0.3769	$ 5,653.34
21		0.3589	$ -
22		0.3418	$ -
23		0.3256	$ -
24		0.3101	$ -
25		0.2953	$ -
26		0.2812	$ -
27		0.2678	$ -
28		0.2551	$ -
29	$ 15,000	0.2429	$ 3,644.19
		NET PRESENT VALUE	**$ 18,506.24**

Well Cleaning/Replacement (every 10 years)

Year	Payment	Discount Factor	Present Value
1		0.9524	$ -
2		0.9070	$ -
3		0.8638	$ -
4		0.8227	$ -
5		0.7835	$ -
6		0.7462	$ -
7		0.7107	$ -
8		0.6768	$ -
9		0.6446	$ -
10	$ 15,000	0.6139	$ 9,208.70
11		0.5847	$ -
12		0.5568	$ -
13		0.5303	$ -
14		0.5051	$ -
15		0.4810	$ -
16		0.4581	$ -
17		0.4363	$ -
18		0.4155	$ -
19		0.3957	$ -
20	$ 15,000	0.3769	$ 5,653.34
21		0.3589	$ -
22		0.3418	$ -
23		0.3256	$ -
24		0.3101	$ -
25		0.2953	$ -
26		0.2812	$ -
27		0.2678	$ -
28		0.2551	$ -
29	$ 15,000	0.2429	$ 3,644.19
		NET PRESENT VALUE	**$ 18,506.24**

Remedial Alternative Cost Estimate
Areas 1 & 2 Groundwater
Lockformer - Lisle, Illinois

Alternative 3: Groundwater Containment

ITEM DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST	SUBTOTAL
RECOVERY WELL INSTALLATION					
Drilling and Development (5 Wells)	5	EA	$ 3,500	$ 17,500	
Survey	1	LS	$ 1,500	$ 1,500	
Bulk Soil Transport and Disposal	20	TN	$ 120	$ 2,400	
Bulk Water Transport and Disposal	650	GAL	$ 1	$ 650	$ 22,050
RECOVERY WELL PIPING SYSTEM					
Recovery Well Vaults	5	EA	$ 500	$ 2,500	
Recovery Pumps (pneumatic)	5	EA	$ 1,500	$ 7,500	
Piping Installation w/trench backfill & compaction	500	LF	$ 70	$ 35,000	
Air Line for Pumps	1,300	LF	$ 5	$ 6,500	$ 51,500
GROUNDWATER TREATMENT SYSTEM					
Equalization Tank, Diffuser, pumps, control panel	1	LS	$ 50,000	$ 50,000	
System Piping Installation	1	LS	$ 15,000	$ 15,000	
Electrical Installation	1	LS	$ 8,000	$ 8,000	
Sanitary Sewer Connection	1	LS	$ 15,000	$ 15,000	$ 88,000
CONSTRUCTION SUBTOTAL					**$ 161,550**
OTHER DIRECT COSTS					
ENGINEERING & DESIGN	1	LS	$ 64,620		$ 64,620
PERMITTING	1	LS	$ 11,309		$ 11,309
HEALTH & SAFETY	1	LS	$ 8,078		$ 8,078
CONSTRUCTION OVERSIGHT	1	LS	$ 40,388		$ 40,388
CONTINGENCIES	1	LS	$ 24,233		$ 24,233
CLOSURE/DECOMMISSIONING	1	LS	$ 40,388		$ 40,388
TOTAL CAPITAL COST					**$ 350,564**
ANNUAL OPERATION & MAINTENANCE (for 30 years)					
Quarterly Monitoring/Reporting	1	YR	$ 30,000	$ 30,000	(Present Value)
Biannual Monitoring/Reporting	29	YR	$ 20,000	$ 302,821	
Activated Carbon Replacement	30	YR	$ 5,000	$ 80,705	
Sequestering Agent/Maintenance	30	YR	$ 5,000	$ 80,705	
System Operation/Periodic Maintenance	30	YR	$ 25,000	$ 403,527	
Well Cleaning/Replacement (every 10 years)	3	EA	$ 15,000	$ 18,506	
Recovery Well Cleaning/Pump Replacement (every 10 years)	3	EA	$ 17,000	$ 20,974	$ 937,239
GRAND TOTAL COST					**$ 1,287,803**

Note: All O&M Costs are in Net Present Value unless otherwise noted.

Net Present Value Calculations
Alternative 3 - Groundwater Containment

Biannual Monitoring/Reporting

Year	Payment	Discount Factor	Present Value
1	$ 20,000	0.9524	$ 19,047.62
2	$ 20,000	0.9070	$ 18,140.59
3	$ 20,000	0.8638	$ 17,276.75
4	$ 20,000	0.8227	$ 16,454.05
5	$ 20,000	0.7835	$ 15,670.52
6	$ 20,000	0.7462	$ 14,924.31
7	$ 20,000	0.7107	$ 14,213.63
8	$ 20,000	0.6768	$ 13,536.79
9	$ 20,000	0.6446	$ 12,892.18
10	$ 20,000	0.6139	$ 12,278.27
11	$ 20,000	0.5847	$ 11,693.59
12	$ 20,000	0.5568	$ 11,136.75
13	$ 20,000	0.5303	$ 10,606.43
14	$ 20,000	0.5051	$ 10,101.36
15	$ 20,000	0.4810	$ 9,620.34
16	$ 20,000	0.4581	$ 9,162.23
17	$ 20,000	0.4363	$ 8,725.93
18	$ 20,000	0.4155	$ 8,310.41
19	$ 20,000	0.3957	$ 7,914.68
20	$ 20,000	0.3769	$ 7,537.79
21	$ 20,000	0.3589	$ 7,178.85
22	$ 20,000	0.3418	$ 6,837.00
23	$ 20,000	0.3256	$ 6,511.43
24	$ 20,000	0.3101	$ 6,201.36
25	$ 20,000	0.2953	$ 5,906.06
26	$ 20,000	0.2812	$ 5,624.81
27	$ 20,000	0.2678	$ 5,356.97
28	$ 20,000	0.2551	$ 5,101.87
29	$ 20,000	0.2429	$ 4,858.93

NET PRESENT VALUE $ 302,821.47

Activated Carbon Replacement

Year	Payment	Discount Factor	Present Value
1	$ 5,000	0.9524	$ 4,761.90
2	$ 5,000	0.9070	$ 4,535.15
3	$ 5,000	0.8638	$ 4,319.19
4	$ 5,000	0.8227	$ 4,113.51
5	$ 5,000	0.7835	$ 3,917.63
6	$ 5,000	0.7462	$ 3,731.08
7	$ 5,000	0.7107	$ 3,553.41
8	$ 5,000	0.6768	$ 3,384.20
9	$ 5,000	0.6446	$ 3,223.04
10	$ 5,000	0.6139	$ 3,069.57
11	$ 5,000	0.5847	$ 2,923.40
12	$ 5,000	0.5568	$ 2,784.19
13	$ 5,000	0.5303	$ 2,651.61
14	$ 5,000	0.5051	$ 2,525.34
15	$ 5,000	0.4810	$ 2,405.09
16	$ 5,000	0.4581	$ 2,290.56
17	$ 5,000	0.4363	$ 2,181.48
18	$ 5,000	0.4155	$ 2,077.60
19	$ 5,000	0.3957	$ 1,978.67
20	$ 5,000	0.3769	$ 1,884.45
21	$ 5,000	0.3589	$ 1,794.71
22	$ 5,000	0.3418	$ 1,709.25
23	$ 5,000	0.3256	$ 1,627.86
24	$ 5,000	0.3101	$ 1,550.34
25	$ 5,000	0.2953	$ 1,476.51
26	$ 5,000	0.2812	$ 1,406.20
27	$ 5,000	0.2678	$ 1,339.24
28	$ 5,000	0.2551	$ 1,275.47
29	$ 5,000	0.2429	$ 1,214.73

NET PRESENT VALUE $ 75,705.37

Net Present Value Calculations
Alternative 3 - Groundwater Containment

System Operation/Periodic Maintenance

Year	Payment	Discount Factor	Present Value
1	$ 25,000	0.9524	$ 23,809.52
2	$ 25,000	0.9070	$ 22,675.74
3	$ 25,000	0.8638	$ 21,595.94
4	$ 25,000	0.8227	$ 20,567.56
5	$ 25,000	0.7835	$ 19,588.15
6	$ 25,000	0.7462	$ 18,655.38
7	$ 25,000	0.7107	$ 17,767.03
8	$ 25,000	0.6768	$ 16,920.98
9	$ 25,000	0.6446	$ 16,115.22
10	$ 25,000	0.6139	$ 15,347.83
11	$ 25,000	0.5847	$ 14,616.98
12	$ 25,000	0.5568	$ 13,920.94
13	$ 25,000	0.5303	$ 13,258.03
14	$ 25,000	0.5051	$ 12,626.70
15	$ 25,000	0.4810	$ 12,025.43
16	$ 25,000	0.4581	$ 11,452.79
17	$ 25,000	0.4363	$ 10,907.42
18	$ 25,000	0.4155	$ 10,388.02
19	$ 25,000	0.3957	$ 9,893.35
20	$ 25,000	0.3769	$ 9,422.24
21	$ 25,000	0.3589	$ 8,973.56
22	$ 25,000	0.3418	$ 8,546.25
23	$ 25,000	0.3256	$ 8,139.28
24	$ 25,000	0.3101	$ 7,751.70
25	$ 25,000	0.2953	$ 7,382.57
26	$ 25,000	0.2812	$ 7,031.02
27	$ 25,000	0.2678	$ 6,696.21
28	$ 25,000	0.2551	$ 6,377.34
29	$ 25,000	0.2429	$ 6,073.66

NET PRESENT VALUE $ 378,526.84

Recovery Well Cleaning/Pump Replacement (every 10 years)

Year	Payment	Discount Factor	Present Value
1	$ -	0.9524	$ -
2	$ -	0.9070	$ -
3	$ -	0.8638	$ -
4	$ -	0.8227	$ -
5	$ -	0.7835	$ -
6	$ -	0.7462	$ -
7	$ -	0.7107	$ -
8	$ -	0.6768	$ -
9	$ -	0.6446	$ -
10	$ 17,000	0.6139	$ 10,436.53
11	$ -	0.5847	$ -
12	$ -	0.5568	$ -
13	$ -	0.5303	$ -
14	$ -	0.5051	$ -
15	$ -	0.4810	$ -
16	$ -	0.4581	$ -
17	$ -	0.4363	$ -
18	$ -	0.4155	$ -
19	$ -	0.3957	$ -
20	$ 17,000	0.3769	$ 6,407.12
21	$ -	0.3589	$ -
22	$ -	0.3418	$ -
23	$ -	0.3256	$ -
24	$ -	0.3101	$ -
25	$ -	0.2953	$ -
26	$ -	0.2812	$ -
27	$ -	0.2678	$ -
28	$ -	0.2551	$ -
29	$ 17,000	0.2429	$ 4,130.09

NET PRESENT VALUE $ 20,973.73

Net Present Value Calculations
Alternative 3 - Groundwater Containment

Sequestering Agent

Year	Payment	Discount Factor	Present Value
1	$ 5,000	0.9524	$ 4,761.90
2	$ 5,000	0.9070	$ 4,535.15
3	$ 5,000	0.8638	$ 4,319.19
4	$ 5,000	0.8227	$ 4,113.51
5	$ 5,000	0.7835	$ 3,917.63
6	$ 5,000	0.7462	$ 3,731.08
7	$ 5,000	0.7107	$ 3,553.41
8	$ 5,000	0.6768	$ 3,384.20
9	$ 5,000	0.6446	$ 3,223.04
10	$ 5,000	0.6139	$ 3,069.57
11	$ 5,000	0.5847	$ 2,923.40
12	$ 5,000	0.5568	$ 2,784.19
13	$ 5,000	0.5303	$ 2,651.61
14	$ 5,000	0.5051	$ 2,525.34
15	$ 5,000	0.4810	$ 2,405.09
16	$ 5,000	0.4581	$ 2,290.56
17	$ 5,000	0.4363	$ 2,181.48
18	$ 5,000	0.4155	$ 2,077.60
19	$ 5,000	0.3957	$ 1,978.67
20	$ 5,000	0.3769	$ 1,884.45
21	$ 5,000	0.3589	$ 1,794.71
22	$ 5,000	0.3418	$ 1,709.25
23	$ 5,000	0.3256	$ 1,627.86
24	$ 5,000	0.3101	$ 1,550.34
25	$ 5,000	0.2953	$ 1,476.51
26	$ 5,000	0.2812	$ 1,406.20
27	$ 5,000	0.2678	$ 1,339.24
28	$ 5,000	0.2551	$ 1,275.47
29	$ 5,000	0.2429	$ 1,214.73

NET PRESENT VALUE $ 75,705.37

Well Cleaning/Replacement (every 10 years)

Year	Payment	Discount Factor	Present Value
1	$ -	0.9524	$ -
2	$ -	0.9070	$ -
3	$ -	0.8638	$ -
4	$ -	0.8227	$ -
5	$ -	0.7835	$ -
6	$ -	0.7462	$ -
7	$ -	0.7107	$ -
8	$ -	0.6768	$ -
9	$ -	0.6446	$ -
10	$ 15,000	0.6139	$ 9,208.70
11	$ -	0.5847	$ -
12	$ -	0.5568	$ -
13	$ -	0.5303	$ -
14	$ -	0.5051	$ -
15	$ -	0.4810	$ -
16	$ -	0.4581	$ -
17	$ -	0.4363	$ -
18	$ -	0.4155	$ -
19	$ -	0.3957	$ -
20	$ 15,000	0.3769	$ 5,653.34
21	$ -	0.3589	$ -
22	$ -	0.3418	$ -
23	$ -	0.3256	$ -
24	$ -	0.3101	$ -
25	$ -	0.2953	$ -
26	$ -	0.2812	$ -
27	$ -	0.2678	$ -
28	$ -	0.2551	$ -
29	$ 15,000	0.2429	$ 3,644.19

NET PRESENT VALUE $ 18,506.24

Remedial Alternative Cost Estimate
Areas 1 & 2 Groundwater
Lockformer - Lisle, Illinois

Alternative 4: No Action

ITEM DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST	SUBTOTAL
No Construction Required					
			$ -	$ -	
			$ -	$ -	
			$ -	$ -	
			$ -	$ -	$ -
CONSTRUCTION SUBTOTAL					**$ -**
OTHER DIRECT COSTS					
ENGINEERING & DESIGN	1	LS	$ -		$ -
PERMITTING	1	LS	$ -		$ -
HEALTH & SAFETY	1	LS	$ -		$ -
CONSTRUCTION OVERSIGHT	1	LS	$ -		$ -
CONTINGENCIES	1	LS	$ -		$ -
CLOSURE/DECOMMISSIONING	1	LS	$ -		$ -
TOTAL CAPITAL COST					**$ -**
ANNUAL OPERATION & MAINTENANCE (for 30 years)					
Quarterly Monitoring/Reporting	1	YR	$ 30,000	$ 30,000	(Present Value)
Biannual Monitoring/Reporting	29	YR	$ 20,000	$ 302,821	
Well Cleaning/Replacement (every 10 years)	3	EA	$ 15,000	$ 18,506	$ 351,328
GRAND TOTAL COST					**$ 351,328**

Note: All O&M Costs are in Net Present Value unless otherwise noted.

Net Present Value Calculations
Alternative 4 - No Action

Biannual Monitoring/Reporting

Year	Payment	Discount Factor	Present Value
1	$ 20,000	0.9524	$ 19,047.62
2	$ 20,000	0.9070	$ 18,140.59
3	$ 20,000	0.8638	$ 17,276.75
4	$ 20,000	0.8227	$ 16,454.05
5	$ 20,000	0.7835	$ 15,670.52
6	$ 20,000	0.7462	$ 14,924.31
7	$ 20,000	0.7107	$ 14,213.63
8	$ 20,000	0.6768	$ 13,536.79
9	$ 20,000	0.6446	$ 12,892.18
10	$ 20,000	0.6139	$ 12,278.27
11	$ 20,000	0.5847	$ 11,693.59
12	$ 20,000	0.5568	$ 11,136.75
13	$ 20,000	0.5303	$ 10,606.43
14	$ 20,000	0.5051	$ 10,101.36
15	$ 20,000	0.4810	$ 9,620.34
16	$ 20,000	0.4581	$ 9,162.23
17	$ 20,000	0.4363	$ 8,725.93
18	$ 20,000	0.4155	$ 8,310.41
19	$ 20,000	0.3957	$ 7,914.68
20	$ 20,000	0.3769	$ 7,537.79
21	$ 20,000	0.3589	$ 7,178.85
22	$ 20,000	0.3418	$ 6,837.00
23	$ 20,000	0.3256	$ 6,511.43
24	$ 20,000	0.3101	$ 6,201.36
25	$ 20,000	0.2953	$ 5,906.06
26	$ 20,000	0.2812	$ 5,624.81
27	$ 20,000	0.2678	$ 5,356.97
28	$ 20,000	0.2551	$ 5,101.87
29	$ 20,000	0.2429	$ 4,858.93

NET PRESENT VALUE $ 302,821.47

Well Cleaning/Replacement (every 10 years)

Year	Payment	Discount Factor	Present Value
1		0.9524	$ -
2		0.9070	$ -
3		0.8638	$ -
4		0.8227	$ -
5		0.7835	$ -
6		0.7462	$ -
7		0.7107	$ -
8		0.6768	$ -
9		0.6446	$ -
10	$ 15,000	0.6139	$ 9,208.70
11		0.5847	$ -
12		0.5568	$ -
13		0.5303	$ -
14		0.5051	$ -
15		0.4810	$ -
16		0.4581	$ -
17		0.4363	$ -
18		0.4155	$ -
19		0.3957	$ -
20	$ 15,000	0.3769	$ 5,653.34
21		0.3589	$ -
22		0.3418	$ -
23		0.3256	$ -
24		0.3101	$ -
25		0.2953	$ -
26		0.2812	$ -
27		0.2678	$ -
28		0.2551	$ -
29	$ 15,000	0.2429	$ 3,644.19

NET PRESENT VALUE $ 18,506.24